REFERENCE 26

Oregon Department of Environmental Quality, May 1996, *Mercury in Oregon Lakes, Water Pollution Control, 1993 – 1994,* 61 pages.

InSight Consultants
Phone: 541-849-2724
FAX: 541-849-3378
insight@rosenet.net

Water Pollution Control

1993 — 1994

MERCURY IN OREGON LAKES

Prepared by:

Avis Newell
Water Quality Division

Doug Drake
Laboratory Division
Water Monitoring Section

Barbara L. Stifel
Water Quality Division

May 1996

Printed on recycled paper.

ACCESSIBILITY INFORMATION

This publication is available in alternate format (e.g., large type, braille) by calling DEQ Public Affairs at (503) 229-5766. People with hearing impairments can call DEQ's TDD number at (503) 229-6993.

ACKNOWLEDGMENTS

Technical Advice & Assistance

Larry Curtis ..... *Oregon State University*

Ron Geitgey ..... *Oregon Department of Geology & Mineral Ind.*

Herschel Henderly ..... *U.S. Army Corps of Engineers*

Colleen Henson ..... *U.S. Fish & Wildlife*

Ken Kauffman ..... *Oregon Health Division*

Bruce Schuld ..... *Idaho DEQ*

Al Smith ..... *Oregon Department of Fish & Wildlife*

Ian Waite ..... *U.S. Geological Survey*

Dave Zimmer ..... *U.S. Federal Bureau of Reclamation*

Coordinating — Fish Collection

Al Smith ..... *Oregon Department of Fish & Wildlife*

Collecting Fish

Wayne Bowers ..... *Oregon Department of Fish & Wildlife*

Ted Fies ..... *Oregon Department of Fish & Wildlife*

Steve Marx ..... *Oregon Department of Fish & Wildlife*

Ray Perkins ..... *Oregon Department of Fish & Wildlife*

Terry Shrader ..... *Oregon Department of Fish & Wildlife*

Amy Stuart ..... *Oregon Department of Fish & Wildlife*

Mark Wade ..... *Oregon Department of Fish & Wildlife*

Jeff Ziller ..... *Oregon Department of Fish & Wildlife*

Fish Age Information

Lisa Borgerson ..... *Oregon State University*

Mercury Analysis

George DiDomenico ..... *Oregon DEQ — Water Quality Lab*

Langdon Marsh, Director ..... *Oregon Department of Environmental Quality*

Mike Downs, Water Quality Division Administrator ..... *Oregon DEQ*

Kevin Downing, Surface Water Section Acting Manager ..... *Oregon DEQ*

Bonnie Smith ..... *Layout Design, Graphic, & Typesetting*

EXECUTIVE SUMMARY

The Oregon Department of Environmental Quality (DEQ) is charged with monitoring water quality for all waterbodies of the state. Monitoring the level of contaminants in fish and sediment is one component of the agency's water quality program. This report focuses on mercury in fish tissue collected by Oregon DEQ during 1993 and 1994. This data is supplemented with data collected by the Idaho Department of Health (West, 1994), and with historic data from the Owyhee Basin (Allen-Gil, et al., 1995; Oregon DEQ, 1992; see Appendix A), and from Antelope Reservoir (see Appendix A).

The DEQ study included fish tissue data from 15 systems, and sediment samples from 12 sites. These sites were chosen based on the presence of watershed sources of mercury; most sites had identified sources, while a few reservoirs without known sources were included as background sites. In addition, preference was given to lakes with popular fisheries. Because of the interest in human exposure to mercury, game species were targeted. Our collection of sediment samples was more investigative than informative.

The results confirmed the relationship between elevated mercury concentrations in fish with cinnabar geology or historical mercury mining activity within the watershed. The data also showed a direct correlation between higher tissue concentrations and fish age. Our data also suggested that piscivorous fish tend to have higher body burdens of mercury.

Reservoirs containing fish with mercury concentrations above safe levels for human consumption were identified. Owyhee, Cottage Grove, and Ochoco reservoirs were expected to have high levels due to known sources, and study results confirmed this. In contrast, high mercury concentrations were observed in East Lake. This was not anticipated, but highlighted the need to include geothermal activity among the potential sources for mercury. Not all lakes with watershed sources of mercury had fish populations with tissue levels high enough to warrant health advisories. Currently, human consumption advisories are posted on five Oregon waterbodies: Owyhee Reservoir, Jordan Creek, Antelope Reservoir, East Lake, and Cottage Grove Reservoir. While the Idaho Health Department has posted an advisory on Brownlee Reservoir, located on the Oregon-Idaho border, fish tissue concentrations of these fish are not sufficiently high to warrant an advisory under Oregon Health Division policy.

RECOMMENDATIONS

A review of these data have resulted in five recommendations for further work relating to mercury contamination in Oregon's waters:.

- *Identify watersheds at risk for mercury contamination;*
- *Study seasonal variability of mercury concentration in fish;*
- *Establish a sediment sampling and analysis protocol;*
- *Determine mercury levels in hatchery fish;*
- *Assess mercury contamination in wildlife..*

Some of these recommendations have been addressed during the 1995 field season, and others will be addressed in future years.

TABLE OF CONTENTS

APPENDICES

List Of Tables

List Of Figures

1

INTRODUCTION

This report focuses on work by DEQ during 1993 and 1994 to characterize mercury in fish from Oregon lakes, and provides the reader with an overview of research by others on mercury in fish from Oregon waters. Oregon has both natural and anthropogenic sources of mercury. Mercury mines and cinnabar deposits contribute mercury to surface waters from erosion of mining areas, and surficial or disturbed cinnabar (HgS) deposits. Anthropogenic sources include tailings from gold mining, and from releases of elemental mercury especially in regions where gold mining occurred. So far, we have no evidence of significant atmospheric sources of mercury.

The work reported here evaluated the mercury content of fish in various lakes, with the intention of identifying those lakes where fish consumption should be limited. While both human and wildlife health is a concern, to date studies in Oregon have been directed largely at human consumption. The reasons for this are two-fold. The Food and Drug Administration has set guidelines for fish tissue mercury concentrations of commercial fish, and the U.S. Environmental Protection Agency (EPA) has set values for human health advisories, but no such criteria have been set at either a state or federal level for wildlife protection. In addition, humans can be advised to limit their consumption, while wildlife cannot. At present, options for mitigation are few and poorly understood, so despite a known hazard to wildlife, little could be done to decrease the hazard.

1.1 HUMAN HEALTH THREAT OF METHYLMERCURY

The deaths of a number of people and the occurrence of serious neurological diseases, brain damage, and paralysis in others at Minamata Bay and Nigata, Japan, in the 1950s and 1960s caused by methylmercury poisoning, focused concern on the human health effects of this compound (Smith and Smith, 1975). Human health effects have also been documented as a result of the consumption of contaminated grain in Iraq (Bakir, *et al.* 1973). Wildlife have also been affected by methylmercury, largely as a result of ingesting food high in mercury, from either geologic or anthropogenic sources (Wren, 1986).

Methylmercury is formed in the aquatic environment when inorganic forms of mercury are converted by biological mechanisms. This transformation is largely the result of microbial activity. Methylmercury accumulates in fish and other

aquatic predators, becoming more concentrated in organisms higher in the food web. In Oregon, aquatic organisms have been shown to accumulate levels of methylmercury which pose a health threat to the humans and wildlife which consume them.

While methylmercury is the form of mercury most harmful when ingested, analysis for it is more costly and complex than the analysis for total mercury. The EPA recommends that total mercury be determined in fish contaminant monitoring programs, making the conservative assumption that all mercury present is methylmercury. Studies have shown that in fish three years of age and older, methylmercury comprises at least 80 percent of the total mercury concentration (U.S. EPA, 1993). Therefore, our studies report total mercury, with the understanding that methylmercury may be present in lower concentrations, and is the major health concern.

1.2 SOURCES OF MERCURY IN OREGON'S WATERS

The sources of mercury in Oregon's environment are natural deposits of cinnabar related to geothermal and volcanic activity, mercury rich ores and tailings disturbed during mercury mining practices, and mercury remaining after use in placer mining (Buhler et al, 1973; Allen-Gil *et al.* (1995). While atmospheric deposition of mercury from both natural gassing of the earth's crust and emissions of fossil fuel combustion, smelting operations, various manufacturing processes, and waste incineration are potential sources of mercury in our waters (U.S. EPA, 1994a), researchers including Buhler *et al* (1973) and Allen-Gil *et al.* (1995) have found these to be secondary to geologic sources in Oregon.

All of the sites where we have observed elevated fish tissue concentrations or sediment levels are in watersheds where there are abandoned mines, a history of gold mining, surficial cinnabar deposits, or geothermal activity. However, not all regions with these indicators present have elevated mercury in fish tissue or sediment. To date, we have largely sampled sites with suspected sources of mercury so our sample of sites without watershed mercury sources is small. Pristine sites, where we have not identified any mercury sources, have fish tissue concentrations low in mercury, suggesting that regional or long-range atmospheric deposition is not significant.

1.3 REGULATORY AND REFERENCE VALUES FOR MERCURY

Oregon has not adopted any rules regarding fish tissue contaminants, mercury included. The levels of mercury in fish used to trigger human health concerns have varied over the years due to changes in policy, and calculation of human risk. Some early studies of mercury in fish relied upon the FDA guidance or limit for mercury in fish for determining the level at which human health might be impaired by consumption of the fish. The FDA recommended guidance concentrations for mercury established in 1970 became a regulatory limit in 1972; fish with more than 0.5 mg/kg mercury were not allowed to be sold commercially.

Due to a court challenge of its 0.5 mg/kg limit by the commercial fishing industry, in 1982 the FDA established a formal limit for mercury in fish of 1.0 mg/kg. This action level considered economic impact as well as human health, and became the level of concern for agencies in Oregon that evaluated the human health effects of mercury in fish.

The most recently published EPA guidelines (U.S. EPA 1994b) recommend that women of childbearing age (considered a high risk group) limit consumption at fish tissue mercury concentrations between 0.4 and 0.6 mg/kg. An evaluation of these EPA recommendations indicates that children under the age of six should limit their consumption of fish with a mercury concentration of 0.2 mg/kg to one four ounce meal per month.

In 1993 the EPA established screening values (SVs) for a group of 14 analytes (U.S. EPA, 1993). These screening values are defined as concentrations of target analytes in fish that are of potential human health concern. The EPA recom-

mends that the values above an SV for an analyte in fish trigger more intensive site-specific monitoring and/or an evaluation of the associated human health risk. The recommended SV for mercury of 0.6 mg/kg was developed to give full priority to the protection of human health.

EPA's evaluation considered the high risk groups, pregnant women or women planning to have children, children under the age of six, fetuses, the elderly, and people with impaired organ function, and derived the more protective value of 0.6 mg/kg. The guidelines for fish consumption for healthy adults are based on an assumed consumption rate over a 70-year period. Based on this revised screening value, several waterbodies in the state have become the focus for additional studies of mercury in fish.

1.4 WATER QUALITY IMPAIRMENT AND FISH ADVISORIES

Although Oregon does not have rules pertaining to tissue concentrations of mercury, Oregon's Water Quality Standards (Oregon Administrative Rules, Chapter 340, Division 41) do require that "water quality ... shall be managed to protect the recognized beneficial uses." Human consumption of fish is one such beneficial use.

Declaration of a waterbody as "Water Quality Impaired", results in the listing of the waterbody in a legal document filed with the U.S. Environmental Protection Agency, referred to as the 303(d) list. These waterbodies will be evaluated for appropriate management alternatives that address the impaired use. Standards or guidelines established by other agencies for mercury in fish may be used by DEQ to assess the impairment of fishing as a beneficial use. In addition to those waterbodies with health advisories posted for mercury, the DEQ has included additional sites as water quality impaired due to mercury on the current draft 303(d) list. These are listed in Table 1-1.

The determination of beneficial use impairment differs from the issuance of fish consumption advisories. In Oregon, fish consumption advisories are issued by the Oregon Health Division (OHD) and/or local health units. An explanation of how this is done is included in Appendix B. As a first cut, they compare the average fish tissue concentrations from available data to the EPA screening value of 0.6 mg Hg/kg. Additionally, they inspect the available data in terms of species present, the number and size of fish in the sample, and the mercury concentrations observed. Once they have determined that a health risk is present, they use the available data and the U.S. EPA guidelines (1994b) to calculate the recommended consumption rates of fish from the waterbody in question. DEQ and other agencies have provided information to OHD on mercury in fish to the OHD for the consideration of human health advisories.

Fish consumption advisories have been placed on five waterbodies in Oregon. The advisories warn people about the hazard of consuming mercury laden fish, and outline reasonable fish consumption rates for species of various sizes from the different waterbodies. Mercury accumulation in fish differs among waterbodies, so too, do the advisories. A list of the waterbodies with mercury advisories appears in Table 1-1, and the individual advisories for each waterbody are in Appendix C.

1.5 SCOPE AND OBJECTIVES OF THIS REPORT

This report describes the work done by DEQ during 1993 and 1994, identifying the sampled sites, describing the sampling and analytical methods, and presenting the results. Some of the existing data have been included in tables and figures as deemed appropriate. All of the data discussed in this report are included in Appendix A. Interpretation and discussion of these results is limited because the amount of data is limited. Small numbers of fish have been sampled, confounded by the range of species and age classes present in those samples. Therefore, only general observations of the data are presented here. The two objectives of this report are to document the work that has been completed to date, and to share these data with others for comparative purposes. Finally, we have presented recommendations for future work in Oregon.

Table 1-1: Waterbodies of Oregon Which Are Considered to Have Impaired Water Quality Due to Mercury, or That Have Human Health Advisories Limiting the Consumption of Fish, Due to High Mercury Concentrations

Water Quality Impaired		
Site	**Location**	**Impairment & Data Source**
Burnt River; Mouth to Clarks Creek	Powder River Basin	Mercury in Tissue – 1994 304(l) List*
Rogue River; Illinois River to Applegate River	Rogue River Basin	Mercury in Tissue – 1994 304(l) List*
Coast Fork Willamette River; Mouth to Cottage Grove	Willamette Basin	Mercury in Sediment – 1994 304(l) List*
Dorena Reservoir	Willamette/Coast Fork	Mercury in Tissue – Appendix A
Middle Fork Willamette River; Mouth to Dexter Lake	Willamette Basin	Mercury in Water Column – USGS (1995)
South Santiam River; Mouth to Foster Reservoir	Willamette Basin	Mercury in Water Column – USGS (1995)
Beaverton Creek; Mouth to headwaters	Willamette/Tualatin Basin	Mercury in Sediment – 1994 304(l) List
Yamhill River; Mouth to Salt Creek	Willamette Basin	Mercury in Water Column – USGS (1995)
Health Advisories		
Site	**Location**	**Advisory Date****
Cottage Grove Reservoir	Lane County	1979, 1987
East Lake, Newberry Crater	Deschutes County	1994, 1995
Antelope Reservoir	Malheur County	1989
Owyhee Reservoir	Malheur County	1989, 1994
Jordan Creek	Malheur County	1989

* The 304(l) list of waterbodies with levels of pollutants which are above guidance values for fish tissue or sediment, and appears in the Oregon's Water Quality Status and Assessment Report (305(b) report, Department of Environmental Quality, 1994) to the U.S. EPA.

** The dates include both the original and updated health advisories.

2

METHODS

2.1 SAMPLING SITES AND SPECIES

There are several watershed indicators of potential mercury contamination in aquatic systems, including cinnabar deposits, past mercury mining, and/or past placer mining activity. Changes in water level of wetlands and impoundments also exacerbate mercury problems and methylation (Johnston, *et al.*, 1991). Morrison and Therien (1991) found that mercury in reservoir fish could be entirely attributed to reservoir flooding. This study of a Canadian impoundment in an area with no elevated levels of mercury in the soils or anthropogenic sources of mercury suggested that the change in hydrologic conditions accounted for the significant increase in mercury in the fish of the impoundments.

During 1993 and 1994, the DEQ chose to sample fish and sediments in a variety of lakes and reservoirs to determine the extent of mercury contamination. Mercury problems in Cottage Grove and Owyhee Reservoirs had already been documented. Due to the known influences of reservoir hydrology on mercury cycling, several more reservoirs, both with and without known mercury sources, were sampled. East and Paulina Lakes were sampled as a result of other studies that demonstrated high Mercury (Hg) levels in fish from East Lake. Crescent Lake is a natural and presumably pristine lake, but has fluctuating water levels because it is used for irrigation.

Due to the emphasis on human health issues, game species were the targeted fish in this study. Information was gathered from Oregon Department of Fish and Wildlife (ODFW) and US Army Corp of Engineers (USACE) about the size and species of fish being stocked and caught from the reservoirs. Lakes with high fishing pressure have received a higher priority for sampling in this study. This strategy reflects an emphasis on human health concerns. Only fish that were of legally harvestable size were collected.

Lakes, fish species, and sediments sampled are shown in Table 2-1. Locations of sites sampled for fish in both 1993 and 1994, as well as historical data discussed in this report, are shown on Figure 2-1. Table 2-1 reflects the sample sizes obtained in this study, rather than the targeted numbers as the targeted numbers were not always obtained.

Not all data presented here were analyzed by the same analytical laboratory. Data from Brownlee Reservoir on the Idaho border were collected by the Idaho Bureau of Environmental Health (West, 1994). Fish from Cottage Grove Reservoir were

Table 2-1: Dates, Number of Fish, and Sediment Grain* Size Are Indicated for Sites Sampled by the Oregon Department of Environmental Quality During 1993 and 1994

Data are included in Appendix A.

Waterbody	Date	Species	No. of Fish	Sediment	Previous Data	Comments
Willamette Valley						
Cottage Grove Reservoir	06/13/94	Bullhead	6	None	OSU, 1974 & 1990	Mercury in Basin
Coast Fork Willamette River Below Cottage Grove Dam	05/15/94	Bluegill	1	None		Mercury in Basin
		Cutthroat	5			
		Whitefish	3			
Dorena Reservoir	07/15/93	Largemouth Bass	6	Whole		Historic Placer Mining
		Bluegill	1			
Dorena Reservoir	06/14/94	Largemouth Bass	7	None		Placer Mining in Watershed
		Bullhead	2			
	07/11/94	Largemouth Bass	6			
Row River Below Dorena Dam	05/15/94	Cutthroat	5	None		Placer Mining in Basin
		Largemouth Bass	5			
Fern Ridge Reservoir	07/13/93	Black Crappie	2	None		No Known Hg
		Carp	2			
		Largemouth Bass	1			
Henry Hagg Reservoir	07/12/93	Largemouth Bass	7	None		No Known Hg
Cascades						
Crescent Lake	09/22/93	–	–	Whole		No Known Mercury (Hg)
East Lake	10/26/94	Brown	14	None	USFS, 1994	Geothermal Activity
		Kokanee	2			
		Rainbow	7			
Green-Peter Reservoir	06/15/94	Largemouth Bass	2	None		Placer Mining in Basin
		Rainbow	1			
	07/12/94	Largemouth Bass	8			
		Squawfish	1			
Hills Creek Reservoir	07/14/93	Coarse Scale Sucker	2	None		No Known Mercury (Hg)
		Largemouth Bass	1			
Paulina Lake	06/08/94	Brown Trout	3	None		No Known Mercury (Hg)
		Rainbow	3			

* Either whole grain or fine grain sediment less than 0.63 μm collected.

Table 2-1: Dates, Number of Fish, and Sediment Grain* Size Are Indicated for Sites Sampled by the Oregon Department of Environmental Quality During 1993 and 1994 (Continued)

Data are included in Appendix A.

Waterbody	Date	Species	No. of Fish	Sediment	Previous Data	Comments
Eastern Oregon						
Brownlee Reservoir	April 1994 (Sampled by the State of Idaho, not by Oregon)	Smallmouth Bass	20	None		Cinnabar, Possible Good Mining, Downstream of Known Sources
		Black Crappie	19			
		White Crappie	23			
		Rainbow Trout	7			
		Yellow Perch	5			
		Carp	12			
		Catfish	42			
Prineville Reservoir	06/01/93	Coarse Scale Sucker	1	None		Cinnabar Deposits
		Smallmouth Bass	1			
		Yellow Bullhead	1			
Ochoco Reservoir	08/11/94	Rainbow	6	Fine – 2 Sites		After Refilling Reservoir
Owyhee River Near Mouth	11/02/93	Carp	3	Whole	See Koenber, 1995	Cinnbar, Placer Mining
Owyhee Reservoir	09/28/94	Smallmouth Bass	1	None		Mercury in Basin
		Channel	9			
		Catfish	3			
		Yellow Perch	–			
Owyhee River at Jordan Creek	08/09/94	–	–	Fine		Mercury in Basin
Owyhee River at N. Canal Siphon Below Dam	08/09/94	–	–	Fine		Mercury in Basin
Owyhee River Between Rome & Reservoir – at Sand Spring	08/09/94	–	–	Fine		Mercury in Basin
Owyhee River Rome Boat Launch	08/09/94	–	–	Fine		Mercury in Basin
Owyhee River Above Rome at Three Forks	08/09/94	–	–	Fine		Mercury in Basin
Powder River	09/94	–	–	Fine		–
Phillips Reservoir	09/27/94	Black Crappie	2	None		Gold Mining in Basin
		Rainbow	3			
		Smallmouth Bass	5			

* Either whole grain or fine grain sediment less than 0.67 μm Collected.

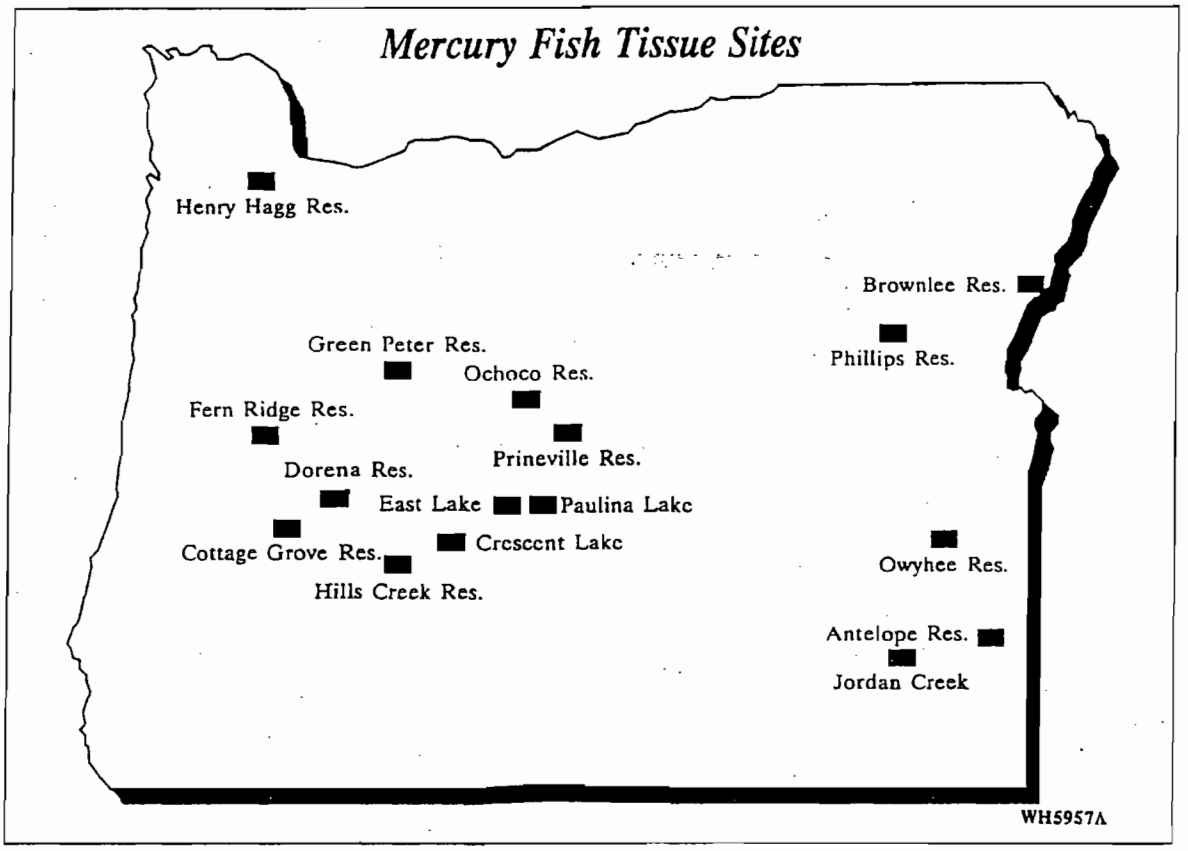


Figure 2-1: A Map of Oregon Showing the Sites Sampled for Fish Tissue Mercury During 1993, 1994, and Selected Historical Data

analyzed by researchers at Oregon State University (see Appendix A). No overlap data comparing DEQ data with these laboratories is available.

However, overlap data from the DEQ lab and the contract lab that analyzed the fish tissue from Antelope Reservoir are available. A paired t-test of these overlap data indicate that on average, the DEQ analysis values are higher than the contract lab (two tailed test $p=0.011$). Only the contract data are available for Antelope Reservoir so these values may underestimate fish tissue concentrations at that site.

2.1.1 Background Information on Sites

- ***Willamette Valley Lakes:***

Cottage Grove Reservoir — This reservoir was built by the Army Corps of Engineers in 1942. Both cinnabar deposits and the currently abandoned highest mercury production mine in the state are present in the watershed. A human health advisory recommending limited consumption of fish from this reservoir was first posted in 1979, and has had periodic modification since. More recently, ODFW reported that black bullheads were a targeted human food source. Because the advisory is based on data from largemouth bass, more information was desired for other species.

Willamette River Coast Fork — Cottage Grove Reservoir, which has a health advisory posted, is on this river. We desired information about fish downstream of the reservoir to determine if mercury was high in these fish as well.

Dorena Reservoir — Dorena Reservoir is an im-

poundment located a few miles east and north of Cottage Grove on the Row River, a tributary to the Willamette. Geitgey (1993) stated that:

> *"The Cottage Grove drainage is underlain primarily by sandstones and siltstones, largely derived from volcanics [mercury mineral deposits have been large enough for commercial mining]; the Dorena drainage is underlain by these sediments as well as a variety of volcanic rock types. The drainage basin of Dorena Lake includes the Bohemia mining district from which gold, silver, copper, lead, and zinc have been produced. ...metallic mercury was used in the gold recovery processing."*

Row River — Dorena Reservoir is on the Row River, a tributary to the Willamette River. Anglers have asked about the level of mercury in fish downstream of the reservoir given the elevated levels in the fish from the reservoir.

Fern Ridge Reservoir — This is another Corps of Engineers impoundment, located on the Long Tom River west of Eugene, and dates back to 1941. This reservoir is used for recreation during summer months, and flood control during winter. No potential mercury sources to this lake have been identified.

Hagg Lake — Henry Hagg Lake on Scoggins Creek in northwestern Oregon is an impoundment with high recreational use and no indicators of mercury contamination.

- ***Cascade Lakes:***

Crescent Lake — Crescent Lake, a natural lake with a dam in the Cascade Lakes area of central Oregon, receives heavy recreational use throughout the summer and is used for irrigation. However, its shoreline is undeveloped and the forest unaltered. There are no known indicators of possible mercury contamination.

East and Paulina Lakes — East and Paulina are natural lakes located in the Newberry Crater, a volcanic caldera, 25 miles south-southeast of Bend in the Deschutes National Forest. These lakes were not identified as waterbodies likely to have elevated levels of mercury and were not a part of the original study. However, early in 1994 the U.S. Forest Service had fish from the lakes analyzed as part of an Environmental Impact Statement (EIS) for a proposed geothermal project in the area (U.S. Forest Service, 1994). Results showed elevated levels of mercury in the fish from East Lake. Since these two lakes are popular resort and fishing areas, ODFW asked that DEQ sample fish from these lakes. Rainbow and brown trout were collected from each lake in June 1994, which led to the issuance of an advisory for East Lake in spring 1994.

Green Peter Reservoir — Green Peter Reservoir is on the Middle Santiam River, a tributary to the Willamette River in the western Cascades. The Quartzville Mining District encompassed the Quartzville Creek and Middle Santiam River which feed this reservoir. A number of gold stamp mills operated in the 1890s and there was small scale lode and placer mining in the 1930s (Brooks, and Ramp, 1968). Rainbow trout of harvestable size (nine to eleven inches), are stocked in the spring. Bass and kokanee were introduced in the past, and now reproduce naturally in the reservoir.

Hills Creek Reservoir — Hills Creek Reservoir is an impoundment lying directly east of Dorena Reservoir on the Middle Fork of the Willamette. There are no reported occurrences of either mercury or precious metal mineralization and no history of mining activity. It is however, in a geothermal area (Geitgey, 1993).

- ***Eastern Oregon Lakes:***

Prineville Reservoir — Prineville Reservoir, a major recreation area on the Crooked River in Central Oregon, was chosen because it lies in an area of cinnabar deposits.

Ochoco Reservoir — Ochoco Reservoir in central Oregon is located on Ochoco Creek near Prineville. Its primary purpose is to provide irrigation water for the agricultural lands in the area. It also has heavy recreational use, with a popular

rainbow trout fishery (Johnson *et al.*, 1985). However, in 1993 the U.S. Bureau of Reclamation discovered that the earthen dam was leaking and in danger of collapse. As a result, it was drained in 1994. DEQ collected trout and sediment for analyses as the reservoir was drained for comparison with post impoundment mercury accumulation in fish and sediment when the reservoir is refilled. Brooks (1971) reported that four mercury mines along the Ochoco Creek in the area of the reservoir had produced about 1,000 flasks. These abandoned mines were not appropriately decommissioned, and are now a source of mercury rich runoff and sediment. In addition, their presence suggests that cinnabar may occur throughout the watershed.

Owyhee Reservoir — The 1994 fish consumption advisory issued by OHD for Owyhee Reservoir was based primarily on data from largemouth bass. Creel surveys by ODFW for the reservoir indicate that other species are also caught and consumed in significant numbers so information on additional species was desired. In addition, the advisory on the reservoir has raised questions about the mercury concentrations in fish being caught either above or below the reservoir.

Jordan Creek — Most of this watershed is located in Idaho, and is thought to be a major contributor of the mercury contamination in Owyhee Reservoir. Smallmouth bass collected here by ODFW in 1989 had an average concentration of mercury of 1.48 mg/kg. This raised concerns about fish from the Owyhee River upstream of the mouth of Jordan Creek.

Sediment was collected in the Owyhee River above and below the mouth of Jordan Creek to help characterize the impact of the creek on the level of mercury in Owyhee Reservoir.

Antelope Reservoir — Antelope Reservoir is an irrigation impoundment, originally constructed in 1913, and enlarged in 1935. It is located in Malheur County, not far from the Idaho border, and receives input from both Jack Creek, a tributary to Jordan Creek, and from high flow diversions from Jordan Creek itself. When full, the reservoir is 3285 acres in surface area but is generally smaller than that due to high summer water usage.

Geologic sources of mercury occur throughout the Owyhee basin, and gold mining may have occurred in the Antelope Reservoir basin as well. Tissue levels for suckers from Antelope Reservoir were measured during the 1970s. Investigations in 1989 were made for rainbow trout; these data are discussed here. The results prompted modifications to the 1988 human health advisory for this system.

Phillips Reservoir — This reservoir is located within the Wallowa-Whitman National Forest on the Powder River, southwest of Baker in east-central Oregon. Upstream of the reservoir, the Sumpter Valley contains piles of rocks dredged up during intense hydraulic mining for gold early in this century (Johnson *et al.*, 1985). Aerial photographs show this area to be as large as the reservoir itself. The Sumpter Mine was one of the most productive gold placer mines in the state while operating in 1913-1924 and 1935-1954 (Brooks, 1968). This gold dredge site has been converted into a wildlife habitat.

Brownlee Reservoir — Brownlee Reservoir is a 15,000 acre impoundment on the Snake River downstream of Ontario, Oregon, and upstream of Hell's Canyon. Its waters are shared by Oregon and Idaho, but the Powder River arm extends into Oregon alone.

Sources of mercury for the Brownlee Reservoir on the Oregon side could be natural cinnabar deposits and past mercury mining in the drainage basins of the Powder and Snake Rivers which feed the reservoir and historical placer gold mining on the Powder River.

Idaho Fish and Game collected smallmouth bass, black crappie, white crappie, rainbow trout, carp, and catfish. All the data presented here are from the Idaho study. Unlike the Oregon studies where whole body mercury was determined for carp and catfish, fillets were sampled from all fish.

As a result of the Idaho study, a fish consumption advisory was issued in May 1994 for mercury in

fish from the Brownlee Reservoir by the Idaho Department of Health and Welfare (West, 1994). However, Oregon Health Division felt that the assumptions used for the risk analysis were more conservative than those used in Oregon for determining consumption advisories for mercury in fish, so no advisory was issued for Oregon waters.

2.2 SAMPLING METHODS

2.2.1 Fish

During 1993, fish were collected by DEQ using an electrofishing boat. The fish were held in lake water in a large plastic barrel until inspected and individually processed. Each fish was individually wrapped in foil, placed in a sealed plastic bag, and held on wet ice in a chest while being transported to DEQ's laboratory. Samples were either analyzed immediately without freezing or kept frozen until analysis. Holding times for frozen samples did not exceed six months.

During 1994, fish were collected by DEQ at the Willamette Basin locations by electrofishing as in 1993. ODFW collected fish from the remaining locations. Trap nets were used at East and Paulina Lakes, while various other methods, electrofishing, trap nets, and gill nets, were used to collect the fish from Phillips Reservoir and sites in the Owyhee Basin. The viscera were removed and the fish frozen before shipment to DEQ.

2.2.2 Sediment

Sediment sampling methods differed between the 1993 and 1994 activities. An Eckman dredge was used to collect samples during 1993 and most were taken at non-wadeable depths. Three to five samples were composited, and the entire fraction was analyzed for total mercury.

This approach was changed during 1994, however. The collection procedure involved sampling five to ten wadeable depositional zones containing fine-grained particulate matter along a 100 meter reach of the stream or reservoir. Each wadeable depositional zone was subsampled several times, in approximate proportion to its size, using a small hand scoop to collect the top 1-2 cm of sediment. Samples were either taken directly from the stream bottom with the scoop (wadeable) or from an Eckman dredge (non-wadeable). The total number of these subsamples composited for a site was between 25 and 50. Composite samples were used to smooth the local-scale variability and to represent the average contaminant levels present at each site. This sample was then split; one portion was used for particle size analysis, and the other was wet sieved through a 63 μm Nylon mesh cloth for total mercury analysis.

The Eckman dredge and polystyrene scoop were cleaned before sampling and between sampling sites by rinsing thoroughly with deionized water, 5 percent nitric acid, and again with deionized water.

During 1993, samples were placed in a polyethylene bottle and held on ice for transport to the lab. The samples were placed in the laboratory freezer until they could be prepared for analysis. Holding times did not exceed six months for frozen samples.

In 1994, fine grain sediment was separated from the composite sample. Within a week of collection, sediment samples were wet sieved through a 63 μm nylon mesh screen with approximately 500 ml deionized water. The <63 μm sediment fraction was then air dried at room temperature for about 25 days. The dried samples were analyzed as in 1993.

2.3 ANALYTICAL METHODS

2.3.1 Fish

The fish were prepared (after partially thawing if frozen) for analyses using clean methods according to EPA recommendations (U.S. EPA, 1993). Fish were measured and weighed. Otoliths or scales were removed for age determination, sex was recorded, and the fish were rinsed with deionized water and filleted. Intact fillets including skin and belly flap were cut into small portions,

wrapped tightly in foil, then placed in the freezer until analyzed. Analyses were done on the edible fillet portion of the game fish and on the whole body for bottom feeding fish. Bottom fish were washed with deionized water, chopped into smaller pieces with a cleaver, and then homogenized in a Hobart blender.

In 1993, samples were homogenized by the chemist, and freeze-dried. The 1994 samples were homogenized prior to digestion, without freeze drying. Lab studies showed no significant differences in these preparation techniques (DiDomenico, 1994). Samples were then digested in stages. First, they were heated at 95°C with aqua regia. The second step of the digestion process included sulfuric acid, potassium permanganate, and potassium persulfate reagent additions, with continued heating at 95°C heat.

EPA method 245.6 (EPA, 1991) using cold vapor atomic absorption spectroscopy with hydroxylamine and stannous chloride technique was followed. Mercury concentrations for fish tissue cited in this report are all in mg Hg/kg wet weight. For ease of reporting, all the concentrations are noted as mg/kg, (equivalent to parts per million).

2.3.2 Sediment

The sediment was dried to a constant weight at 60°C, and ground to a homogenous size in a ball mill grinder for five minutes. The dried aliquot was digested and analyzed using cold vapor atomic absorption spectroscopy conforming to methods 7470 and 7471 (U.S. EPA, 1994c).

2.3.3 Quality Assurance

Dogfish muscle reference tissue used for quality control (material DORM-1), was obtained from the National Research Council of Canada, and used as reference material for both sediment and fish tissue analysis. Every tenth sample was analyzed in duplicate to document precision for both sediment and fish tissue; a similar number of spiked samples were included to ensure that accuracy was maintained. Holding times for fish tissue and sediment samples were six months. The detection limit for fish tissue and sediment was 0.04mg Hg/kg sample.

3

RESULTS AND DISCUSSION

3.1 MERCURY AND FISH SIZE

Data from Dorena Reservoir clearly show that for largemouth bass, body burden of mercury increases with fish size (Figure 3-1). A similar relationship was seen for brown trout in East Lake (Figure 3-2). Median fish tissue concentrations for various species and age classes collected in Oregon during 1993 and 1994 are listed in Table 3-1. Here too, it is clear that the older fish of a given species from each lake tend to have higher mercury concentrations. This effect has been reported for other sites as well (Horwitz *et al.*, 1995; Lasorsa and Allen-Gill, 1995; Wren and MacCrimmon, 1986), and is not surprising as fish size correlates highly with fish age. Fish continue growing despite their age, so one would expect that the longer a fish is in the water, the greater its mercury concentration will be. Thus, in waterbodies with moderately high mercury concentrations, the larger, more desirable fish may be more hazardous to consumers than smaller, younger fish of the same species.

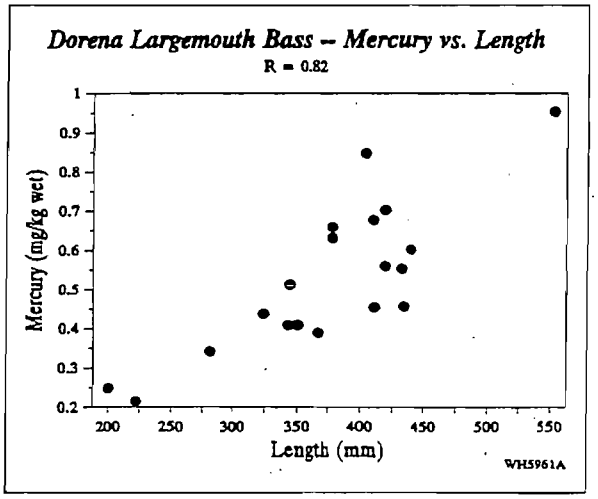


Figure 3-1: A Scatterplot of Fish Tissue Mercury Concentration (mg Hg/kg Wet Tissue) Versus Fish Length (mm) for Largemouth Bass from Dorena Reservoir

3.2 MERCURY AND FISH SPECIES

Distributions of fish tissue concentrations are presented in several figures in the form of box and whisker plots. These are relatively simple to understand. Each "box" represents several samples from a given site, or for a given species, as indicated in the figure. The upper and lower corners of the box, excluding the vertical lines, represent the 75th and 25th percentages (or quartiles) in the sample. In other words, 75 percent of the

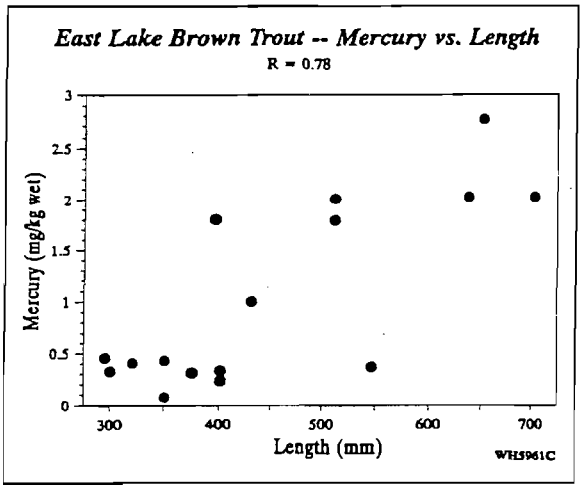


Figure 3-2: A Scatterplot of Fish Tissue Mercury Concentration (mg Hg/kg Wet Tissue) Versus Fish Length (mm) for Brown Trout Bass from East Lake

fish sampled have fish tissue concentrations as low or lower than the level indicated by the upper end of the box, and 25 percent of the sample have fish tissue concentrations as low or lower than the lower end of the box. The horizontal line in the box indicates the sample median value, or 50th percentile. As with the corners of the box, 50 percent of the sample values were lower than this level, and 50 percent were higher than this level. The ends of the whiskers are at the points 1.5 times the inter-quartile range (75th minus the 25th percentiles) from the median. The asterisks above and below the whiskers represent any data that are beyond these values.

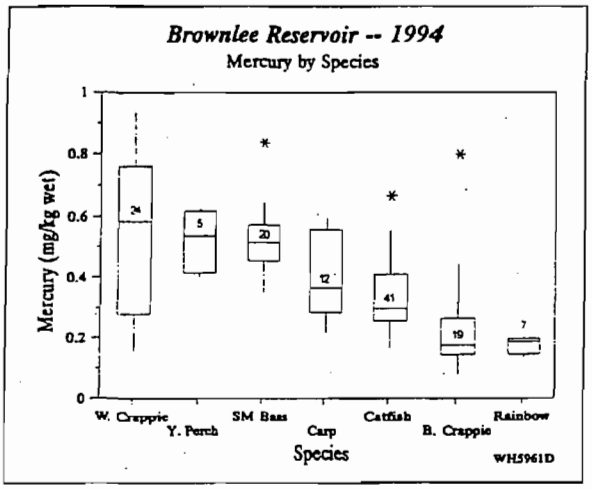
The box and whisker plot (Figure 3-3) of mercury concentration for fish in Brownlee Reservoir (data from Steve West, Idaho Bureau of Environmental Health), located on the Oregon-Idaho border, suggests that within a given system, fish body burdens vary with fish species. While these data represent different sample sizes and ages of species, confounding such an interpretation, this phenomenon has been reported in the literature (Wren and MacCrimmon, 1986; Wren *et al,*, 1991; and Jackson, 1991). Factors that have been shown to influence fish tissue body burdens in addition to age and size include diet, water quality variables such as pH and hardness, habitat preference, metabolic rate, growth rate, and excretory pathways. Table 3-1 shows similar statistics for each species collected from each site.

In addition to age, fish diet is often presumed to be an important factor in mercury body burden between species. Most fish are somewhat opportunistic in their feeding patterns, dependent in part on their habitat, so that differences among individual fish may be as great as diet differences among species. For the fish sampled here, there are not large differences in trophic levels. For example, largemouth bass and brown trout are top predators. Old largemouth bass and trout have mainly piscivorous diets, although either will eat most anything it can catch and consume; individual diets depend on what is available. Smallmouth bass also switch from zooplankton and invertebrate consumers to fish as they increase in size, although as adults, their preferred food is crayfish, rather than vertebrate fish. Yellow perch also change diets as they age, eating zooplankton and invertebrates as young fish, switching to small fish, and particularly fish eggs as they age. Rainbow, kokanee, and both white and black crappie feed on zooplankton, insects and aquatic invertebrates. Bullheads, channel catfish and carp are all bottom feeders. Carp are largely vegetarian, while Bullheads are more carnivorous, with omnivorous diets. Channel catfish are opportunistic feeders, eating benthic invertebrates as younger fish, and including small fish in their diets as they age.

Fish species sampled during 1993 and 1994 tend to include the higher trophic levels of fish; trout and crappie that eat zooplankton and insects, and the higher consumers, bass and brown trout that are mainly piscivorous. There are fewer bottom feeders and vegetarians in our samples, largely due to the emphasis on game fish, and in part due to the fish obtained in the sampling efforts. However, in general one can say that the bottom fish and vegetarian fish species will have lower body burdens of mercury than the top predators in the same lake. This is apparent in the Brownlee data (Figure 3-3), where channel catfish and carp have lower mercury levels than do the bass, yellow perch and white crappie. Details that are not apparent in this figure, are that the catfish and

Table 3-1: Sample Size (n), Minimum, Median, Maximum and Upper and Lower Quartiles of Mercury Concentrations in Parts Per Million (mg/kg) in Fish of All Sizes Collected Between 1992 and 1994 from Oregon and Idaho Waters

Waterbody	Species	n	Minimum	Lower 25%	Median	Upper 25%	Maximum
Brownlee Reservoir	Carp	12	0.22	0.31	0.37	0.56	0.60
	Smallmouth Bass	20	0.35	0.46	0.52	0.58	0.84
	Perch	5	0.40	0.40	0.54	0.58	0.63
	Black Crappie	19	0.08	0.15	0.18	0.27	0.80
	Catfish	42	0.17	0.26	0.31	0.41	0.67
	Rainbow	24	0.13	0.15	0.19	0.20	0.21
	White Crappie	–	0.16	0.29	0.59	0.76	0.94
Coast Fork Willamette River	Cutthroat	5	0.24	0.24	0.36	0.37	0.42
	Whitefish	3	0.06	–	0.11	–	0.11
	Bluegill	1	0.37	–	0.37	–	0.37
Cottage Grove Reservoir	Bullhead	6	0.33	0.33	0.56	0.57	0.75
	Largemouth Bass	12	0.22	0.40	0.44	0.69	1.79
Dorena Reservoir	Largemouth Bass	19	0.21	0.41	0.51	0.65	0.94
	Bullhead	2	0.25	–	0.31	–	0.37
	Bluegill	1	0.35	–	0.35	–	0.35
East Lake	Rainbow	7	0.34	0.44	0.54	0.76	0.92
	Kokanee	2	0.92	–	0.97	–	1.01
	Brown	14	0.13	0.37	0.50	1.87	2.84
Fern Ridge Reservoir	Black Crappie	2	0.06	–	0.06	–	0.07
	Carp	2	0.06	–	0.08	–	0.11
	Largemouth Bass	1	0.09	–	–	–	0.09
Green Peter Reservoir	Squawfish	1	0.37	–	0.37	–	0.37
	Rainbow	1	0.04	–	0.04	–	0.04
	Largemouth Bass	10	0.14	0.18	0.24	0.27	0.33
Hagg Reservoir	Largemouth Bass	7	0.07	0.08	0.08	0.08	0.10
Hills Creek Reservoir	Coarse Scale Sucker	2	0.09	–	0.09	–	0.09
	Largemouth Bass	1	0.07	–	0.07	–	0.07
Ochoco	Rainbow	19	0.23	0.26	0.34	0.60	0.79
Owyhee River	Carp	3	0.24	–	0.28	–	0.38
Owyhee Reservoir	Channel Catfish	20	0.24	0.60	0.77	0.99	1.47
	Perch	3	0.42	–	0.45	–	1.04
Paulina Lake	Brown	3	0.06	–	0.06	–	0.06
	Rainbow	3	0.03	–	0.03	–	0.03
Phillips Reservoir	Rainbow	3	0.14	–	0.15	–	0.16
	Smallmouth Bass	5	0.27	0.27	0.39	0.40	0.41
	Black Crappie	2	0.35	–	0.37	–	0.39
Prineville Reservoir	Coarse Scale Sucker	1	0.06	–	0.06	–	0.06
	Bullhead	1	0.07	–	0.07	–	0.07
	Smallmouth Bass	1	0.15	–	0.15	–	0.15
Row River	Largemouth Bass	5	0.29	0.29	0.41	0.43	0.58
	Cutthroat	5	0.09	0.09	0.10	0.10	0.13



***NOTE:* The number of fish of each species is denoted in the graph.**

Source: Idaho Bureau of Environmental Health (West, 1994)

Figure 3-3: A Box and Whisker Diagram Showing the Distribution of Fish Tissue Mercury (mg Hg/kg Wet Tissue) for Each Species Collected from Brownlee Reservoir

carp samples include fish of more varied and larger sizes than do the samples of crappie, perch or bass (see Appendix A for data). Age data were not available for any of the fish. The influence of trophic level on fish mercury concentration has been reported in the literature as well (Wren & MacCrimmon, 1986; Jackson, 1991). Although we have not sampled lower trophic levels of fish from all the systems with significant mercury sources, we can surmise that fish lower in the trophic system would likely not have higher mercury concentrations than similar aged fish from the higher trophic levels.

3.3 MERCURY IN OREGON WATERS

Of the lakes for which we have data, fish with the highest mercury concentrations were from Antelope Reservoir, in the Owyhee Basin (Figure 3-4). Antelope Reservoir is in the Jordan Creek Basin, on the more southern arm feeding Jordan Creek, called Jack Creek. Both Jordan and Jack Creeks have a history of mining activity in their watersheds, as well as mercuric mineral deposits. East Lake, a caldera lake with presumably natural geothermal mercury sources has fish with the second highest maximum mercury concentrations (and high median values) so far measured in the state (Table 3-1). Older brown trout from this lake have average body burdens approaching 2.5 mg Hg/kg of fish. Smallmouth bass in Owyhee Reservoir also had high body burdens of mercury, with Hg average concentrations of 1.16 mg/kg in 4 to 5 year old fish. Mercury sources to Owyhee include both natural sources from cinnabar in the watershed, and anthropogenic elemental mercury left over from placer mining activities of silver and gold in the watershed, particularly in the Jordan Creek area.

The lakes containing fish with the four highest mercury concentrations in Table 3-2 have advisories posted to limit human consumption of these fish. The Oregon Health Division uses an overall average of 0.6 mg Hg/kg of fish tissue to trigger the issuance of an advisory. Therefore, although the older largemouth bass in Dorena Reservoir have concentrations of mercury greater than the 0.6 screening level, the overall average tissue concentration is 0.33 mg/kg, so the Health Division does not consider the risk of eating fish from Dorena Reservoir to be sufficiently great to post an advisory. Likewise for fish from Brownlee Reservoir, while the state of Idaho has posted an advisory for fish consumption from Brownlee Reservoir, the Idaho agency uses different screening values for deciding when to post an advisory.

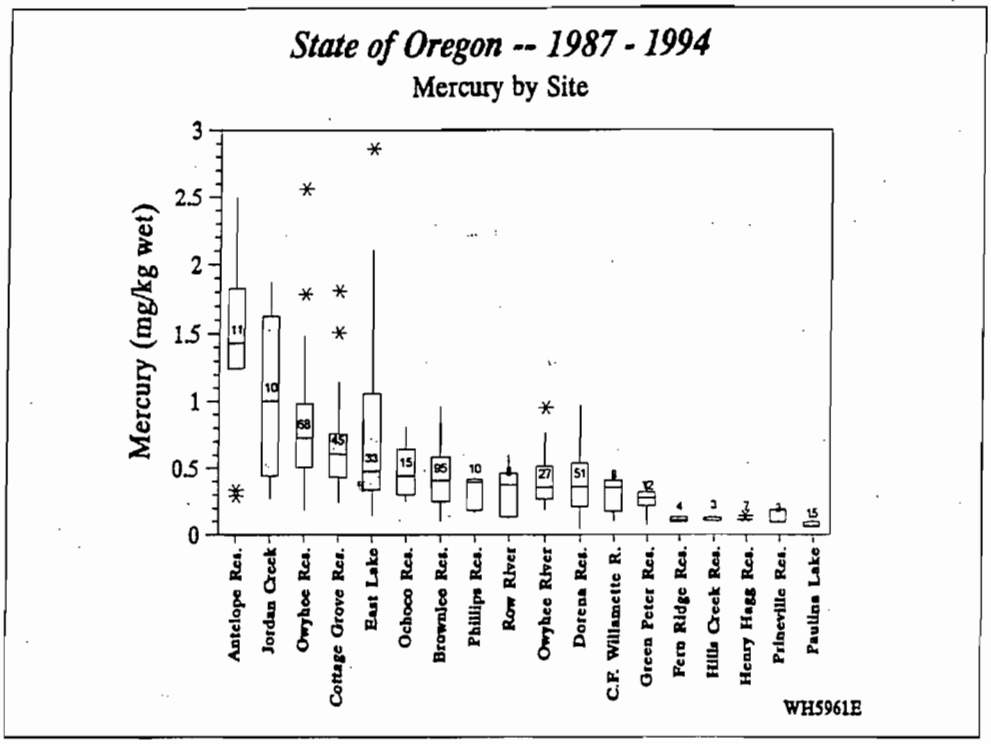
It should be noted that while some of the fish in East Lake have the highest mercury concentrations of any yet measured in the state, median fish concentrations in East Lake are not as high as median tissue concentrations in fish from Antelope Reservoir, Owyhee River, Jordan Creek or Cottage Grove Reservoir (Figure 3-4).

Data collected since 1989 (Appendix A), including the Idaho Health Department and Oregon State University studies, were combined to obtain the statistics presented in Figure 3-4. Collection and analytical methods may vary somewhat among these studies. However, even larger issues influencing the differences among these sites are the number, species composition, age and size of fish in the samples

Table 3-2: Median Mercury Concentrations (mg/kg), Age Class (in Years), Sample Size (n), and Fishery Status of Selected Fish Species from Oregon Lakes

Lakes are sorted by mercury concentration — highest to lowest. Data from Antelope and Brownlee Reservoirs are not included as no information on fish age was available.

Site	Species	Age	Median	n	Fishery
East Lake	Brown	10	2.84	1	Advisory Issued by OHD
		5–6	1.97	4	
		3–4	0.42	8	
	Kokanee	3	0.97	2	
	Rainbow	2–3	0.54	7	
Owyhee Reservoir	Smallmouth Bass	4–5	0.97	7	Advisory Issued by OHD
		2–3	0.62	8	
	Carp	–	0.30	3	
Cottage Grove Reservoir	Largemouth Bass	4–5	0.55	11	Advisory Issued by OHD
		1–3	0.62	8	
	Brown Bullhead	1–2	0.44	5	
Dorena Reservoir	Largemouth Bass	6	0.55	3	Open
		4–5	0.43	8	
		1–3	0.30	21	
Ochoco Reservoir	Rainbow	4	0.38	4	Open
		2–3	0.43	14	
		1	0.38	1	
Brownlee Reservoir	Smallmouth Bass	–	0.53	20	Advisory Issued by and for the State of Idaho Advisory Not Issued by Oregon
	White Crappie	–	0.53	24	
	Yellow Perch	–	0.52	5	
	Carp	–	0.41	12	
	Catfish	–	0.34	42	
	Black Crappie	–	0.24	19	
	Rainbow	–	0.17	7	
Row River	Largemouth Bass	3–4	0.41	5	Open
	Cutthroat	1	0.10	5	
Phillips Reservoir	Black Crappie	3–5	0.37	2	Open
	Smallmouth Bass	3	0.39	5	
	Rainbow	1	0.15	3	
Owyhee Reservoir Below Dam	Carp	–	0.30	3	Open
Coast Fork Willamette River	Cutthroat	1–2	0.36	5	Open
Green Peter Reservoir	Largemouth Bass	2–4	0.23	9	Open
Paulina Lake	Brown	4	0.06	3	Open
	Rainbow	3	<0.04	3	

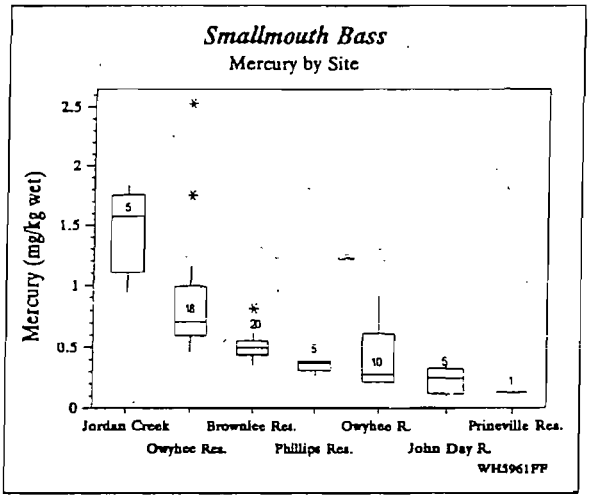


NOTE: **Numbers indicate the number of fish in the sample. Shaded boxes indicate sites with an Oregon health advisory. In addition, there is an Idaho health advisory on Brownlee Reservoir.**

Figure 3-4: A Box and Whisker Diagram Showing the Distribution of Fish Tissue Mercury (mg Hg/kg Wet Tissue) for All Species Sampled at Each Site

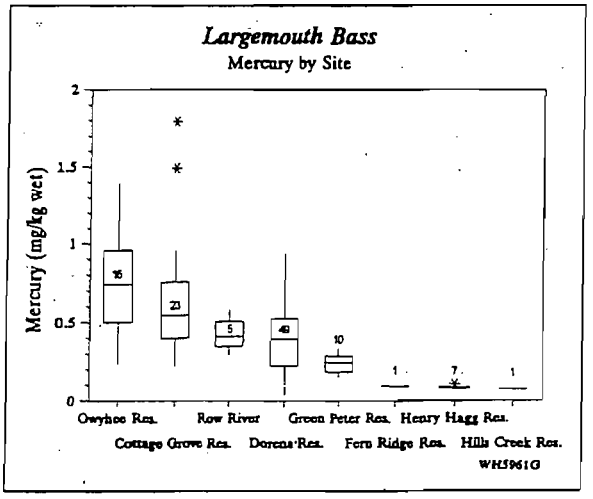
from each lake. Thus, differences among median values may not represent true differences among fish populations at these sites. This Figure then, should be interpreted in a qualitative way rather than a quantitative way. For example, one can see a progression from those lakes where there is an advisory posted (shaded boxes), to those where fish tissue concentrations were at or near our detection limit. For more detailed information about the fish tissue data, including age, length, weight and tissue concentration for individual fish, see Appendix A. Similar plots are presented in Figures 3-5 – 3-8, where box and whisker plots demonstrate the differences in fish tissue concentrations for various species from the sites where we were able to collect those species. All size classes are included in the box and whisker plots (Figures 3-5 – 3-8); median mercury values for selected age classes for each species and site are shown in Table 3-2. These data support the finding of increased mercury levels in older fish.

Unfortunately, we know little about the mercury sources to these systems. For the lakes where advisories are posted, there are watershed sources of mercury, either from erosion of surficial deposits or related to geothermal activity, as in East Lake. However, we have little understanding of how influential these sources will be. Mercury levels of concern are not observed at all sites with known sources. For example, both Green Peter and Phillips Reservoirs have mercury in their watersheds, but to date, samples from each show relatively low mercury (<0.4 ppm). Mercury in fish from sites downstream of highly impacted areas, such as the Coast Fork of the Willamette River or the Owyhee River



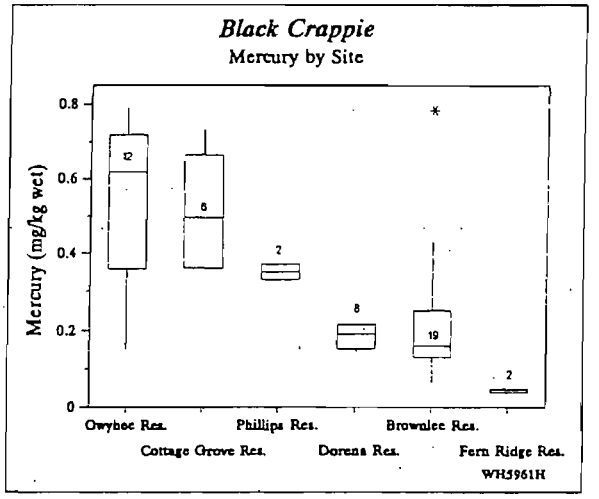
NOTE: **The number of fish of each species is denoted in the graph. Oregon health advisories have been posted on Jordan Creek and the Owyhee Reservoir, and an Idaho health advisory has been posted on Brownlee Reservoir.**

Figure 3-5: A Box and Whisker Diagram Showing the Distribution of Fish Tissue Mercury (mg Hg/kg Wet Tissue) for Smallmouth Bass Collected from Several Sites



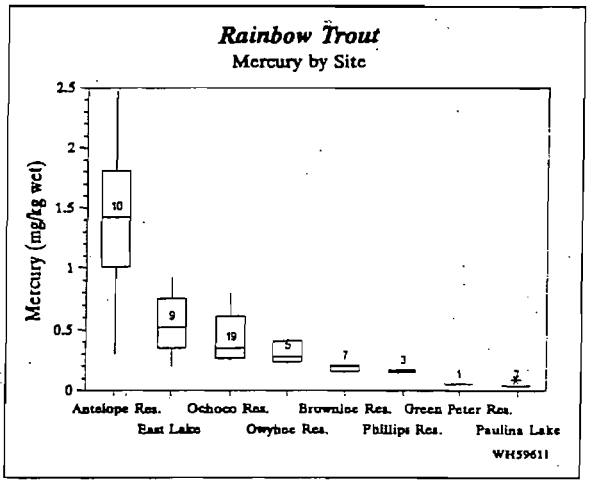
NOTE: **The number of fish at each site is denoted in the graph. Oregon health advisories have been posted on Owyhee and Cottage Grove Reservoirs.**

Figure 3-6: A Box and Whisker Diagram Showing the Distribution of Fish Tissue Mercury (mg Hg/kg Wet Tissue) for Largemouth Bass Collected from Several Sites



NOTE: **The number of fish at each site is denoted in the graph. Oregon health advisories have been posted on Owyhee and Cottage Grove Reservoirs. In addition, there is an Idaho health advisory on Brownlee Reservoir.**

Figure 3-7: A Box and Whisker Diagram Showing the Distribution of Fish Tissue Mercury (mg Hg/kg Wet Tissue) for Black Crappie Collected from Several Sites



NOTE: **The no. of fish at each site is denoted in the graph. Oregon health advisories have been posted on Antelope Reservoir & East Lake. There is an Idaho health advisory on Brownlee Reservoir.**

Figure 3-8: A Box and Whisker Diagram Showing the Distribution of Fish Tissue Mercury (mg Hg/kg Wet Tissue) for Rainbow Trout Collected from Several Sites

below the dam, are also difficult to predict. Samples at these sites, downstream of areas with posted advisories, have measurable mercury concentrations that are not sufficiently high for posting advisories.

3.4 SEDIMENT

Whole sediment samples collected during 1993 from Dorena Reservoir, Crescent Lake, and the Owyhee River all had mercury concentrations less than the DEQ laboratory's minimum reportable level of 0.08 mg/kg dry, as did fine sediment collected during 1994 from Phillips Reservoir and in the upper Owyhee Basin (Table 3-3). Fine particulates from sites in, or downstream of known sources, such as the Willamette River Coast Fork below Cottage Grove Reservoir, the Powder River, and Jordan Creek and the Owyhee River below Jordan Creek, had measurable levels of mercury. These values are certainly elevated compared to other sites in Oregon even in the same drainage, where levels were below detection limits. However, it is also useful to compare these to sites outside of Oregon. Sediments from Minnesota and Wisconsin Lakes ranged between 0.09 and 0.24 mg/kg (Agency for Toxic Substances and Disease Registry, 1994; Sorenson *et al.* 1990), while those from reservoirs in the Columbia Basin were as high as 0.9 mg/kg (Bortelson *et al.* 1994). The higher values generally observed in the western U.S. parallel data reported for soil concentrations, and probably reflect the more extensive volcanic sources (Koerber, 1995).

While there is some relationship between known watershed sources of mercury and our observed sediment concentrations, we failed to see mercury in all sediment samples from impacted waterbodies. This illustrates the fact that contaminated sediments may have a patchy distribution. In addition, in lakes and reservoirs, the depth at which the sediment occurs may influence the rate at which methylation and subsequent transport through the food chain occurs. Deeper sediments may become anoxic, increasing methylation rates (Bloom and Effler, 1990). Periodic flooding of wetlands and reservoirs (Driscoll *et al*, 1995; Porvari and Verta, 1995; Bodaly, *et al.* 1984), even those with background mercury levels, is also known to increase methylation rates. Our

Table 3-3: Sediment Mercury Concentrations (mg/kg) for Whole or Fine Grained Sediment Collected During 1993 and 1994

Site		Year Sampled	Size Fraction	Mercury Concentration (mg/kg)
Crescent Lake		1993	Whole	< 0.08
Dorena Reservoir		1993	Whole	< 0.08
Owyhee Reservoir		1993	Whole	< 0.08
Willamette River Coast Fork		1994	Fine	0.59
Phillips Basin	Phillips Reservoir	1994	Fine	0.08
	Powder River		Fine	0.26
Ochoco Reservoir	Surface Sediment	1994	Fine	0.20
	25 cm Deep		Fine	0.13
Owyhee Basin	Three Forks Area	1994	Fine	< 0.08
	Owyhee @ Rome	1994	Fine	< 0.08
	Jordan Creek	1994	Fine	0.60
	Owyhee @ Sand Springs	1994	Fine	0.16
	North Canal Siphon	1994	Fine	< 0.08

data represent analysis of either whole sediment or the fine fraction, <0.63 μm. No split sampling of these fractions was completed, so although we observed higher mercury concentrations in the fine sediments than in the whole fraction, these differences may be due to location as well as the size fraction of the sediment sample. Due to our lack data and the paucity of models that predict the relative contribution of methylated mercury from these zones, observing a meaningful correlation between sediment and fish tissue mercury concentrations is unlikely.

4

RECOMMENDATIONS

Below are recommendations for additional work relating to mercury in fish from Oregon's waters. While these activities may begin during the next year, they will undoubtedly continue over the next few years:

- ***Identify Watersheds at Risk for Mercury Contamination*** — So far, our efforts to identify watersheds that are at risk for mercury contamination have focused on areas with known sources of mercury and high fishing pressure, or in areas with existing data. In order to streamline prioritization of sites for investigation, we are putting together a geographical database including geology, mining sources, fishing pressures, and existing fish tissue data, among many other variables. This will provide a way to evaluate several factors in a spatial display. In addition, it will provide the framework for developing models that better predict where mercury bioaccumulation may occur.

- ***Study Seasonal Variability of Mercury Concentration in Fish*** — Inspection of data from a number of sources (particularly the Oregon DEQ and Oregon State University) suggested that seasonal differences may exist in Dorena Reservoir. Explanations for these differences in the literature include changes in hypolimnetic methylation rates that are in turn related to oxygen levels. Whatever the cause, understanding the seasonality in Oregon waters is necessary for the design of successful monitoring and assessment programs, especially when data from different years and different seasons are combined and compared.

- ***Establish Sampling and Analysis Protocol*** — Various sediment protocols have been used by DEQ to sample and analyze sediment. In this report, two different methods were used in the 2 years of the sampling. Having a published protocol for both sampling and analytical methods for all of our mercury work would allow other investigators to follow our methods, improving comparative data analysis.

- ***Measure Mercury in Hatchery Fish*** — For our work we have assumed that the fish collected for analysis have accumulated their mercury burden in the lakes, reservoirs, or rivers from which they were collected. It has been suggested that the hatchery released fish may begin accumulating mercury before release to these systems, if they were raised

in an environment with mercury present. Analysis of hatchery fish of releasable age will indicate what mercury concentrations are present in these fish.

- ***Assess Mercury Contamination in Wildlife*** — To date, our efforts have been targeted toward the risk of human consumption of contaminated fish. However, many wildlife species depend entirely on fish for their diets and may be unable to supplement their diets with untainted fish. Our long-term efforts should include some evaluation of the impact of mercury on wildlife in mercury-rich basins.

5

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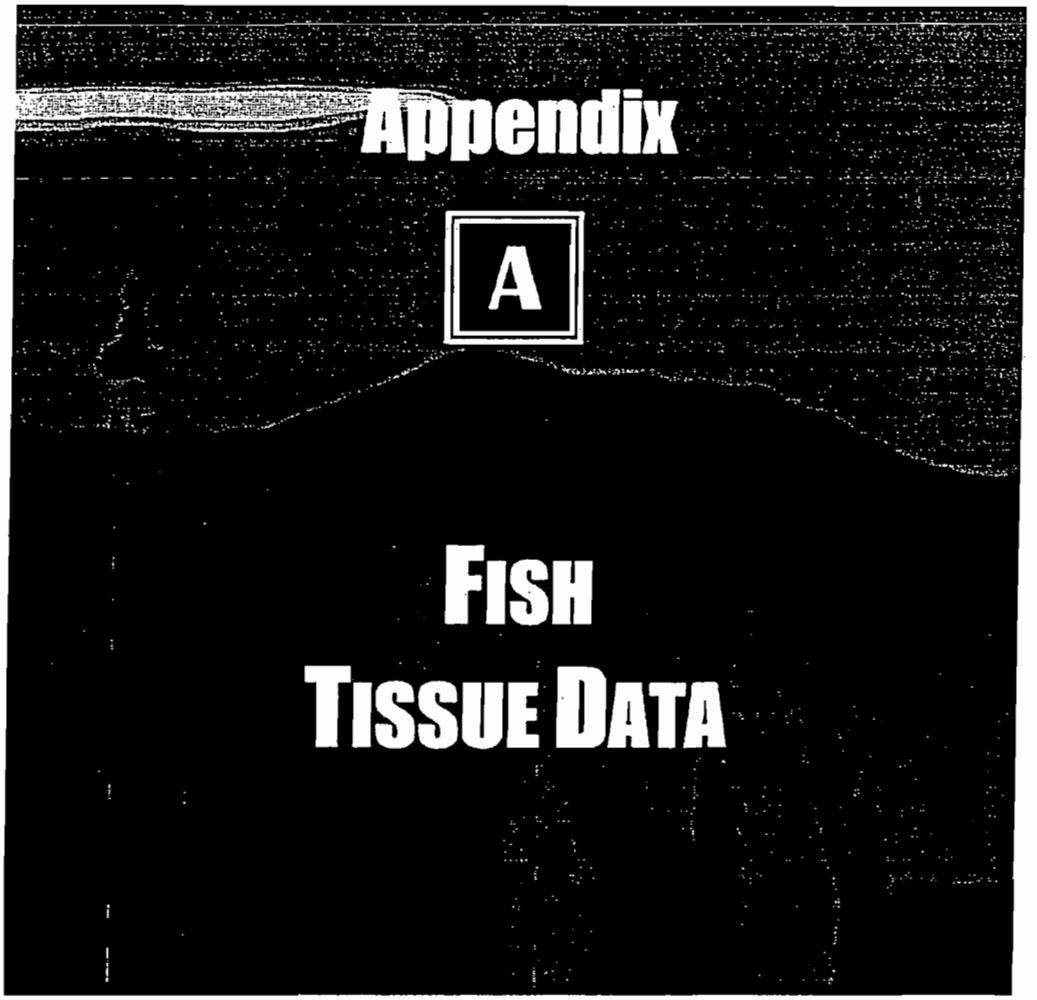

Appendix
A
Fish
Tissue Data

Table A-1: Oregon DEQ — 1987 – 1994 Mercury Fish Tissue Database

(Legend of Column Titles is at the end of Table)

Location Description	Date	Species	Text	Mercury	Age	Length	Weight	Sex	Lipid	Type	Number	Lab
ANTELOPE RESERVOIR AT DEEPEST POINT	08/27/87	Sucker Coarsescale		1.87		431.8				f	2	DEQ
ANTELOPE RESERVOIR AT DEEPEST POINT	07/01/89	Trout Rainbow		0.28		157.48				f		Hibbs
ANTELOPE RESERVOIR AT DEEPEST POINT	07/01/89	Trout Rainbow		0.32		154.94				f		Hibbs
ANTELOPE RESERVOIR AT DEEPEST POINT	09/15/89	Trout Rainbow		1.23		264.16				f		Hibbs
ANTELOPE RESERVOIR AT DEEPEST POINT	09/15/89	Trout Rainbow		1.25		350.52				f		Hibbs
ANTELOPE RESERVOIR AT DEEPEST POINT	09/15/89	Trout Rainbow		1.41		322.58				f		Hibbs
ANTELOPE RESERVOIR AT DEEPEST POINT	09/15/89	Trout Rainbow		1.42		368.3				f		Hibbs
ANTELOPE RESERVOIR AT DEEPEST POINT	08/27/87	Trout Rainbow		1.57		254	91			f	3	DEQ
ANTELOPE RESERVOIR AT DEEPEST POINT	08/27/87	Trout Rainbow		1.8		368.3	612			f	2	DEQ
ANTELOPE RESERVOIR AT DEEPEST POINT	08/27/87	Trout Rainbow		1.81		254	204			f	2	DEQ
ANTELOPE RESERVOIR AT DEEPEST POINT	09/15/89	Trout Rainbow		2.48		228.6				f		Hibbs
BROWNLEE RESERVOIR	09/01/89	Bass Smallmouth		0.13		210.82				f		Hibbs
BROWNLEE RESERVOIR	04/06/94	Bass Smallmouth		0.35		312	481			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Bass Smallmouth		0.4		305	322			f		IDHD
BROWNLEE RESERVOIR	04/07/94	Bass Smallmouth		0.4		305	342			f		IDHD
BROWNLEE RESERVOIR	04/07/94	Bass Smallmouth		0.44		305	348			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Bass Smallmouth		0.46		316	373			f		IDHD
BROWNLEE RESERVOIR	04/07/94	Bass Smallmouth		0.46		319	402			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Bass Smallmouth		0.5		305	343			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Bass Smallmouth		0.52		311	358			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Bass Smallmouth		0.52		306	349			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Bass Smallmouth		0.52		305	336			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Bass Smallmouth		0.52		315	401			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Bass Smallmouth		0.55		333	500			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Bass Smallmouth		0.55		305	395			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Bass Smallmouth		0.56		317	380			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Bass Smallmouth		0.57		309	370			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Bass Smallmouth		0.58		305	411			f		IDHD
BROWNLEE RESERVOIR	04/07/94	Bass Smallmouth		0.61		305	338			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Bass Smallmouth		0.61		325	400			f		IDHD
BROWNLEE RESERVOIR	04/07/94	Bass Smallmouth		0.65		306	363			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Bass Smallmouth		0.84		327	495			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Carp		0.22		556	2362			f		IDHD
BROWNLEE RESERVDIR	04/07/94	Carp		0.26		817	9000			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Carp		0.27		720	5500			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Carp		0.35						f		IDHD
BROWNLEE RESERVOIR	04/05/94	Carp		0.35		749	6750			f		IDHD

Location Description	Date	Species	Text	Mercury	Age	Length	Weight	Sex	Lipid	Type	Number	Lab
BROWNLEE RESERVOIR	04/20/94	Carp		0.36						f		IDHD
BROWNLEE RESERVOIR	04/06/94	Carp		0.38		661	5000			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Carp		0.48		560	5000			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Carp		0.56		796	10800			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Carp		0.56		785	7000			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Carp		0.58		652	4800			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Carp		0.6		714	4540			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.17		485	1100			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.19		450	450			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.21						f		IDHD
BROWNLEE RESERVOIR	04/07/94	Catfish		0.21		512	1030			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.21		330	300			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.22		515	1230			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.23		375	508			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.24		470	1275			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.25		290	350			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.26		315	290			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.26		300	220			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.27		470	1000			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.27		520	1400			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.27		310	400			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.28		325	425			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.28		320	295			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.29		370	400			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.29		350	500			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.29		330	285			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.3		490	1125			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.3		470	900			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.31		510	1100			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.33		420	770			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.34		515	1100			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.35		450	850			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.35		345	380			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.37		395	700			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.37		340	450			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.37		435	925			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.38		520	1380			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.4		320	425			f		IDHD

Location Description	Date	Species	Text	Mercury	Age	Length	Weight	Sex	Lipid	Type	Number	Lab
BROWNLEE RESERVOIR	04/20/94	Catfish		0.41		545	1200			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.43		430	750			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.43		390	700			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.44		450	1025			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.45		385	625			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.46		330	425			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.48		500	1050			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.54		320	400			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.54		450	450			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.56		545	1220			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Catfish		0.67		565	1700			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Crappie Black		0.08						f		IDHD
BROWNLEE RESERVOIR	04/07/94	Crappie Black		0.11		218	197			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Crappie Black		0.11		170	77			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Crappie Black		0.15		166	88			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Crappie Black		0.15		155	54			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Crappie Black		0.16		180	90			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Crappie Black		0.17		226	208			f		IDHD
BROWNLEE RESERVOIR	04/07/94	Crappie Black		0.18		226	194			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Crappie Black		0.18		185	110			f		IDHD
BROWNLEE RESERVOIR	04/07/94	Crappie Black		0.18		171	91			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Crappie Black		0.2		171	86			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Crappie Black		0.2		182	106			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Crappie Black		0.23		166	80			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Crappie Black		0.27		181	113			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Crappie Black		0.27		180	109			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Crappie Black		0.29		221	220			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Crappie Black		0.44		258	295			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Crappie Black		0.45		229	217			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Crappie Black		0.8		269	351			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Crappie White		0.16		215	300			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Crappie White		0.17		220	300			f		IDHD
BROWNLEE RESERVOIR	04/07/94	Crappie White		0.17		233	151			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Crappie White		0.17		230	350			f		IDHD
BROWNLEE RESERVOIR	04/07/94	Crappie White		0.22		203	120			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Crappie White		0.28		239	233			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Crappie White		0.3		235	400			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Crappie White		0.31		256	277			f		IDHD

Location Description	Date	Species	Text	Mercury	Age	Length	Weight	Sex	Lipid	Type	Number	Lab
BROWNLEE RESERVOIR	04/06/94	Crappie White		0.31		240	214			f		IDHD
BROWNLEE RESERVOIR	04/07/94	Crappie White		0.35		281	297			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Crappie White		0.47		273	339			f		IDHD
BROWNLEE RESERVOIR	04/07/94	Crappie White		0.57		285	349			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Crappie White		0.61		289	380			f		IDHD
BROWNLEE RESERVOIR	04/07/94	Crappie White		0.67		297	393			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Crappie White		0.68		316	515			f		IDHD
BROWNLEE RESERVOIR	04/07/94	Crappie White		0.71		268	277			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Crappie White		0.75		272	261			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Crappie White		0.75						f		IDHD
BROWNLEE RESERVOIR	04/20/94	Crappie White		0.77						f		IDHD
BROWNLEE RESERVOIR	04/05/94	Crappie White		0.82		278	208			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Crappie White		0.82		284	346			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Crappie White		0.85		294	381			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Crappie White		0.87		301	378			f		IDHD
BROWNLEE RESERVOIR	04/06/94	Crappie White		0.94		303	448			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Perch Yellow		0.4		245	272			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Perch Yellow		0.44		280	449			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Perch Yellow		0.54		260	256			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Perch Yellow		0.61		270	258			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Perch Yellow		0.63		250	240			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Trout Rainbow		0.13		426	1008			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Trout Rainbow		0.15		420	1025			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Trout Rainbow		0.15		437	731			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Trout Rainbow		0.19		353	611			f		IDHD
BROWNLEE RESERVOIR	04/05/94	Trout Rainbow		0.19		420	1095			f		IDHD
BROWNLEE RESERVOIR	04/20/94	Trout Rainbow		0.2		410	1000			f		IDHD
BROWNLEE RESERVOIR	04/07/94	Trout Rainbow		0.21		415	734			f		IDHD
COAST FORK WILLAMETTE D/S COTTAGE GROVE RES	05/15/94	Bluegill		0.37	3	200	198	j	1.4	f		DEQ
COAST FORK WILLAMETTE D/S COTTAGE GROVE RES	05/15/94	Trout Cutthroat		0.24	1	203	73	j	1.3	f		DEQ
COAST FORK WILLAMETTE D/S COTTAGE GROVE RES	05/15/94	Trout Cutthroat		0.28	2	264	139	j	1.5	f		DEQ
COAST FORK WILLAMETTE D/S COTTAGE GROVE RES	05/15/94	Trout Cutthroat		0.36	2	254	133	j	1.7	f		DEQ
COAST FORK WILLAMETTE D/S COTTAGE GROVE RES	05/15/94	Trout Cutthroat		0.38	2	272	178	j	1.3	f		DEQ
COAST FORK WILLAMETTE D/S COTTAGE GROVE RES	05/15/94	Trout Cutthroat		0.42	1	305	292	j	1.5	f		DEQ
COAST FORK WILLAMETTE D/S COTTAGE GROVE RES	05/15/94	Whitefish		0.06	3	305	250	m	1.8	f		DEQ
COAST FORK WILLAMETTE D/S COTTAGE GROVE RES	05/15/94	Whitefish		0.11	3	317	335	m	1.8	f		DEQ
COAST FORK WILLAMETTE D/S COTTAGE GROVE RES	05/15/94	Whitefish		0.11	3	290	202	m	1.5	f		DEQ
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	09/01/90	Bass Largemouth		0.22	3					f		OSU

Location Description	Date	Species	Text	Mercury	Age	Length	Weight	Sex	Lipid	Type	Number	Lab
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Bass Largemouth		0.31	2	227	239			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Bass Largemouth		0.32	1	182	128			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	09/01/90	Bass Largemouth		0.36	2					f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	07/01/92	Bass Largemouth		0.37	3	342.9	596			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Bass Largemouth		0.4	3	273	481			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	07/01/92	Bass Largemouth		0.42	2	228.6	159			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	07/01/92	Bass Largemouth		0.42	4	304.8	379			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	07/01/92	Bass Largemouth		0.43	4	342.9	658			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	09/01/90	Bass Largemouth		0.44	3					f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Bass Largemouth		0.51	3	285	476			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Bass Largemouth		0.55	4	336	872			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	07/01/92	Bass Largemouth		0.59	3	279.4	312			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Bass Largemouth		0.59	3	284	340			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Bass Largemouth		0.62	2	249	338			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	07/01/92	Bass Largemouth		0.64	3	260.35	243			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	07/01/92	Bass Largemouth		0.74	3	292.1	309			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	09/24/94	Bass Largemouth		0.76	1	179	121			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	09/24/94	Bass Largemouth		0.79	2	311	619			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	09/24/94	Bass Largemouth		0.8	3	283	452			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	09/24/94	Bass Largemouth		0.96	5	345	908			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	09/1/90	Bass Largemouth		1.49	4					f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	09/1/90	Bass Largemouth		1.79	5					f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	09/24/94	Bluegill		0.46	2	114	41.2			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	09/24/94	Bluegill		0.61	2	122	55.4			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	09/24/94	Bluegill		0.67	2	116	50.5			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	09/24/94	Bluegill		0.69	3	121	56.1			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Bluegill		0.74	2	163	206			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Bluegill		0.91	3	176	278			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Bluegill		1.13	5	185	289			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Bullhead		0.26	1	147	77			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	06/13/94	Bullhead		0.33		260		f	1	f		DEQ
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Bullhead		0.35	2	237	235			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Bullhead		0.44	2	232	246			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	06/13/94	Bullhead		0.51		265		j	1.7	f		DEQ
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Bullhead		0.53	2	222	222			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	06/13/94	Bullhead		0.56		270		f	1.1	f		DEQ
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	06/13/94	Bullhead		0.56		280		j	1.4	f		DEQ
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	06/13/94	Bullhead		0.57		285		j	1.5	f		DEQ

Location Description	Date	Species	Text	Mercury	Age	Length	Weight	Sex	Lipid	Type	Number	Lab
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	09/24/94	Bullhead		0.63	4	259	344.6			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	09/24/94	Bullhead		0.71	1	247	275.4			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	06/13/94	Bullhead		0.75		280		j	1.7	f		DEQ
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Crappie Black		0.38	1	132	65			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Crappie Black		0.38	2	134	69			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Crappie Black		0.39	2	139	80			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Crappie Black		0.64	3	194	246			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Crappie Black		0.66	4	222	311			f		OSU
COTTAGE GROVE RESERVOIR AT DEEPEST POINT	01/01/93	Crappie Black		0.75	4	215	251			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	11/11/94	Bass Largemouth		0.03	1	158	106			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	11/11/94	Bass Largemouth		0.05	1	163	104			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	11/11/94	Bass Largemouth		0.12	5	354	1200			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	11/11/94	Bass Largemouth		0.15	1	210	213			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	11/11/94	Bass Largemouth		0.19	3	298	765			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	11/11/94	Bass Largemouth		0.19	2	298	699			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	07/15/93	Bass Largemouth		0.209	2	220	161	j	0.2	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	11/11/94	Bass Largemouth		0.21	2	288	611			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	11/11/94	Bass Largemouth		0.22	2	252	444			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Bass Largemouth		0.22	1	173	104			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	11/11/94	Bass Largemouth		0.22	1	188	201			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	07/15/93	Bass Largemouth		0.235	2	200	95	j	0.1	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Bass Largemouth		0.26	1	221	176			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	11/11/94	Bass Largemouth		0.28	5	385	1800			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	07/15/93	Bass Largemouth		0.333	3	280	370	m	0.05	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Bass Largemouth		0.36	2	255	364			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Bass Largemouth		0.38	4	360	1005			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Bass Largemouth		0.39	1	178	123			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	07/11/94	Bass Largemouth		0.4	4	362	750		0.9	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	07/11/94	Bass Largemouth		0.41	3	338	700	f	1.4	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	07/11/94	Bass Largemouth		0.41	3	346	700	m	1.4	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Bass Largemouth		0.42	1	207	189			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	07/11/94	Bass Largemouth		0.43	3	319	600	m	1.4	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	06/14/94	Bass Largemouth		0.45	4	405	1000	m	1.3	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	06/14/94	Bass Largemouth		0.46	6	430	1450	f	1.4	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	07/11/94	Bass Largemouth		0.51	3	338	600	m	1.3	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Bass Largemouth		0.51	3	350	1040			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Bass Largemouth		0.52	3	322	747			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Bass Largemouth		0.53	3	284	677			f		OSU

Table A-1: Oregon DEQ — 1987 – 1994 Mercury Fish Tissue Database (Continued)

Location Description	Date	Species	Text	Mercury	Age	Length	Weight	Sex	Lipid	Type	Number	Lab
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Bass Largemouth		0.53	4	360	1175			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	06/14/94	Bass Largemouth		0.55	6	425	1300	m	1.4	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	06/14/94	Bass Largemouth		0.56	5	410	1250	f	1.4	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	07/11/94	Bass Largemouth		0.61	6	434	1500	f	1.1	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	07/15/93	Bass Largemouth		0.628	4	370	873	m	0.05	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	07/15/93	Bass Largemouth		0.65	3	370	840	m	0.05	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	07/15/93	Bass Largemouth		0.664	4	400	915	m	0.05	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	06/14/94	Bass Largemouth		0.69	5	410	1100	m	1.3	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	06/14/94	Bass Largemouth		0.85	5	395	950	m	1.5	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	06/14/94	Bass Largemouth		0.94	9	545	2900	f	1.2	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	11/11/94	Bluegill		0.01	3	124	63			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	11/11/94	Bluegill		0.01	2	93	29			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	11/11/94	Bluegill		0.02	3	162	138			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	11/11/94	Bluegill		0.03	3	139	106			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	11/11/94	Bluegill		0.04	3	151	119			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	11/11/94	Bluegill		0.06	4	161	142			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	11/11/94	Bluegill		0.1	4	167	195			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Bluegill		0.14	2	100	31			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Bluegill		0.24	1	129	70			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Bluegill		0.25	1	104	32			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Bluegill		0.33	1	73	25			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	07/15/93	Bluegill		0.355	4	215	230	m	0.1	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	06/14/94	Bullhead		0.25		275	164		1	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	06/14/94	Bullhead		0.37		275	116	f	1.2	f		DEQ
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Crappie Black		0.16	2	175	119.5			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Crappie Black		0.17	2	168	130.6			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Crappie Black		0.18	2	170	134.4			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Crappie Black		0.2	2	168	120.7			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Crappie Black		0.22	3	189	172.2			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Crappie Black		0.22	2	180	148.1			f		DSU
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Crappie Black		0.24	2	177	147.4			f		OSU
DORENA RESERVOIR AT DEEPEST POINT	01/01/93	Crappie Black		0.24	2	204	182.5			f		OSU
EAST LAKE AT DEEPEST POINT	05/17/94	Chub Tui		0.12		280	334			f		AGI
EAST LAKE AT DEEPEST POINT	05/17/94	Chub Tui		0.27		235	169			f		AGI
EAST LAKE AT DEEPEST POINT	05/17/94	Chub Tui		0.29		255	232			f		AGI
EAST LAKE AT DEEPEST POINT	05/17/94	Chub Tui		1.42		215	155			f		AGI
EAST LAKE AT DEEPEST POINT	05/17/94	Salmon Atlantic		0.28		315	295			f		AGI
EAST LAKE AT DEEPEST POINT	10/26/94	Salmon Kokanee		0.92	3	340	415	m		f		DEQ

Location Description	Date	Species	Text	Mercury	Age	Length	Weight	Sex	Lipid	Type	Number	Lab
EAST LAKE AT DEEPEST POINT	10/26/94	Salmon Kokanee		1.01	3	270	210	m		f		DEQ
EAST LAKE AT DEEPEST POINT	05/17/94	Trout Brook		0.21		255	181			f		AGI
EAST LAKE AT DEEPEST POINT	05/17/94	Trout Brook		0.38		275	255			f		AGI
EAST LAKE AT DEEPEST POINT	10/26/94	Trout Brown		0.13	3	350	420	f		f		DEQ
EAST LAKE AT DEEPEST POINT	10/26/94	Trout Brown		0.29	4	400	640	m		f		DEQ
EAST LAKE AT DEEPEST POINT	06/08/94	Trout Brown		0.37	4	375	440	m	1.5	f		DEQ
EAST LAKE AT DEEPEST POINT	10/26/94	Trout Brown		0.38		400	700	m		f		DEQ
EAST LAKE AT DEEPEST POINT	06/08/94	Trout Brown		0.38	3	300	250	f	1.3	f		DEQ
EAST LAKE AT DEEPEST POINT	05/17/94	Trout Brown		0.42		545	1750			f		AGI
EAST LAKE AT DEEPEST POINT	06/08/94	Trout Brown		0.46	3	320	225	I	1.7	f		DEQ
EAST LAKE AT DEEPEST POINT	06/08/94	Trout Brown		0.48	4	350	420	m	0.9	f		DEQ
EAST LAKE AT DEEPEST POINT	06/08/94	Trout Brown		0.51	4	295	260	f	1.2	f		DEQ
EAST LAKE AT DEEPEST POINT	10/26/94	Trout Brown		1.06	5	430	750	m		f		DEQ
EAST LAKE AT DEEPEST POINT	10/26/94	Trout Brown		1.86	5	510	1500	m		f		DEQ
EAST LAKE AT DEEPEST POINT	10/26/94	Trout Brown		1.88	3	395	500	f		f		DEQ
EAST LAKE AT DEEPEST POINT	10/26/94	Trout Brown		2.08	5	510	1500	m		f		DEQ
EAST LAKE AT DEEPEST POINT	10/26/94	Trout Brown		2.09	6	635	3800	m		f		DEQ
EAST LAKE AT DEEPEST POINT	05/17/94	Trout Brown		2.09		700	4100			f		AGI
EAST LAKE AT DEEPEST POINT	06/08/94	Trout Brown		2.84	10	650	3200	m	1.1	f		DEQ
EAST LAKE AT DEEPEST POINT	05/17/94	Trout Rainbow		0.18		405	345			f		AGI
EAST LAKE AT DEEPEST POINT	05/17/94	Trout Rainbow		0.34		300	335			f		AGI
EAST LAKE AT DEEPEST POINT	06/08/94	Trout Rainbow		0.34	2	210	100	j	0.9	f		DEQ
EAST LAKE AT DEEPEST POINT	06/08/94	Trout Rainbow		0.44	3	320	440	j	3.1	f		DEQ
EAST LAKE AT DEEPEST POINT	06/08/94	Trout Rainbow		0.51	3	295	280	j	1.2	f		DEQ
EAST LAKE AT DEEPEST POINT	10/26/94	Trout Rainbow		0.54	3	325	310	m		f		DEQ
EAST LAKE AT DEEPEST POINT	06/08/94	Trout Rainbow		0.72	3	240	155	j	0.8	f		DEQ
EAST LAKE AT DEEPEST POINT	06/08/94	Trout Rainbow		0.76	2	200	88	j	0.7	f		DEQ
EAST LAKE AT DEEPEST POINT	06/08/94	Trout Rainbow		0.92	3	280	230	f	1	f		DEQ
FERN RIDGE RESERVOIR AT DEEPEST POINT	07/13/93	Bass Largemouth		0.089	2	280	400	m	0.6	f		DEQ
FERN RIDGE RESERVOIR AT DEEPEST POINT	07/13/93	Carp		0.058		366.67	963		1.7	wb	3	DEQ
FERN RIDGE RESERVOIR AT DEEPEST POINT	07/13/93	Carp		0.108		360	757		0.6	wb	3	DEQ
FERN RIDGE RESERVOIR AT DEEPEST POINT	07/13/93	Crappie Black		0.058		212.5	142	m	0.2	f	2	DEQ
FERN RIDGE RESERVOIR AT DEEPEST POINT	07/13/93	Crappie Black		0.068		196.67	103	j	0.2	f	3	DEQ
GREEN PETER RESERVOIR AT DEEPEST POINT	06/15/94	Bass Largemouth		0.14	2	293		m	1	f		DEQ
GREEN PETER RESERVOIR AT DEEPEST POINT	07/12/94	Bass Largemouth		0.18	3	293	400	f	1.2	f		DEQ
GREEN PETER RESERVOIR AT DEEPEST POINT	07/12/94	Bass Largemouth		0.18	2	248	250	j	1	f		DEQ
GREEN PETER RESERVOIR AT DEEPEST POINT	07/12/94	Bass Largemouth		0.2	3	340	600	f	1	f		DEQ
GREEN PETER RESERVOIR AT DEEPEST POINT	06/15/94	Bass Largemouth		0.22	4	248		f	1.7	f		DEQ

Location Description	Date	Species	Text	Mercury	Age	Length	Weight	Sex	Lipid	Type	Number	Lab
GREEN PETER RESERVOIR AT DEEPEST POINT	07/12/94	Bass Largemouth		0.26	4	345	600	m	1.1	f		DEQ
GREEN PETER RESERVOIR AT DEEPEST POINT	07/12/94	Bass Largemouth		0.26		385	1000	f	1.2	f		DEQ
GREEN PETER RESERVOIR AT DEEPEST POINT	07/12/94	Bass Largemouth		0.28	4	316	500	m	1	f		DEQ
GREEN PETER RESERVOIR AT DEEPEST POINT	07/12/94	Bass Largemouth		0.29	4	332	500	f	1	f		DEQ
GREEN PETER RESERVOIR AT DEEPEST POINT	07/12/94	Bass Largemouth		0.33	4	316	500	m	1	f		DEQ
GREEN PETER RESERVOIR AT DEEPEST POINT	07/12/94	Squawfish		0.37		395	500		1	f		DEQ
GREEN PETER RESERVOIR AT DEEPEST POINT	06/15/94	Trout Rainbow		0.04	1	275		j	1.3	f		DEQ
HENRY HAGG RESERVOIR AT DEEPEST POINT	07/12/93	Bass Largemouth		0.069	1	204	121	j	0.7	f		DEQ
HENRY HAGG RESERVOIR AT DEEPEST POINT	07/12/93	Bass Largemouth		0.075	1	226	170	m	0.2	f		DEQ
HENRY HAGG RESERVOIR AT DEEPEST POINT	07/12/93	Bass Largemouth		0.078	1	218	143	m	0.05	f		DEQ
HENRY HAGG RESERVOIR AT DEEPEST POINT	07/12/93	Bass Largemouth		0.079	1	221	164	m	0.7	f		DEQ
HENRY HAGG RESERVOIR AT DEEPEST POINT	07/12/93	Bass Largemouth		0.08	1	203	116	j	0.05	f		DEQ
HENRY HAGG RESERVOIR AT DEEPEST POINT	07/12/93	Bass Largemouth		0.081	1	200	109	m	1.3	f		DEQ
HENRY HAGG RESERVOIR AT DEEPEST POINT	07/12/93	Bass Largemouth		0.104	1	216	128	j	0.1	f		DEQ
HILLS CREEK RESERVOIR AT DEEPEST POINT	07/14/93	Bass Largemouth		0.069		172.67	71	j	0.05	f	3	DEQ
HILLS CREEK RESERVOIR AT DEEPEST POINT	07/14/93	Sucker Coarsescale		0.089		340	413		0.2	wb	5	DEQ
HILLS CREEK RESERVOIR AT DEEPEST POINT	07/14/93	Sucker Coarsescale		0.094		340	413		0.3	wb	5	DEQ
JORDAN CREEK 1/2 mile u/s mouth	09/01/89	Catfish Channel		0.26		228.6				f		Hibbs
JORDAN CREEK 1/2 MILE U/S MOUTH	09/01/89	Catfish Channel		0.41		228.6				f		Hibbs
JORDAN CREEK 1/2 MILE U/S MOUTH	09/01/89	Catfish Channel		0.43		203.2				f		Hibbs
JORDAN CREEK 1/2 MILE U/S MOUTH	09/01/89	Catfish Channel		0.44		330.2				f		Hibbs
JORDAN CREEK 1/2 MILE U/S MOUTH	09/01/89	Catfish Channel		1.01		304.8				f		Hibbs
JORDAN CREEK AT AROCK BRIDGE	09/01/89	Bass Smallmouth		0.96		223.52				f		Hibbs
JORDAN CREEK AT AROCK BRIDGE	09/01/89	Bass Smallmouth		1.3		269.24				f		Hibbs
JORDAN CREEK AT AROCK BRIDGE	09/01/89	Bass Smallmouth		1.59		350.52				f		Hibbs
JORDAN CREEK AT AROCK BRIDGE	09/01/89	Bass Smallmouth		1.68		241.3				f		Hibbs
JORDAN CREEK AT AROCK BRIDGE	09/01/89	Bass Smallmouth		1.86		360.68				f		Hibbs
OCHOCO RESERVOIR AT DEEPEST POINT	01/01/92	Trout Rainbow		0.23	1	165.1	72			f		OSU
OCHOCO RESERVOIR AT DEEPEST POINT	01/01/92	Trout Rainbow		0.23	2	317.5	370			f		OSU
OCHOCO RESERVOIR AT DEEPEST POINT	01/01/92	Trout Rainbow		0.23	1	165.1	72			f		OSU
OCHOCO RESERVOIR AT DEEPEST POINT	01/01/92	Trout Rainbow		0.25	2	292.1	349			f		OSU
OCHOCO RESERVOIR AT DEEPEST POINT	01/01/92	Trout Rainbow		0.26	2	241.3	208			f		OSU
OCHOCO RESERVOIR AT DEEPEST POINT	01/01/92	Trout Rainbow		0.26	2	292.1	308			f		OSU
OCHOCO RESERVOIR AT DEEPEST POINT	01/01/92	Trout Rainbow		0.28	3	228.6	168			f		OSU
OCHOCO RESERVOIR AT DEEPEST POINT	01/01/92	Trout Rainbow		0.28	1	254	228			f		OSU
OCHOCO RESERVOIR AT DEEPEST POINT	01/01/92	Trout Rainbow		0.29	2	266.7	270			f		OSU
OCHOCO RESERVOIR AT DEEPEST POINT	01/01/92	Trout Rainbow		0.34	2	292.1	279			f		OSU
OCHOCO RESERVOIR AT DEEPEST POINT	01/01/92	Trout Rainbow		0.38	4	368.3	568			f		OSU

Table A-1: Oregon DEQ — 1987 – 1994 Mercury Fish Tissue Database (Continued)

Location Description	Date	Species	Text	Mercury	Age	Length	Weight	Sex	Lipid	Type	Number	Lab
OCHOCO RESERVOIR AT DEEPEST POINT	01/01/92	Trout Rainbow		0.42	1	152.4	55			f		OSU
OCHOCO RESERVOIR AT DEEPEST POINT	05/01/94	Trout Rainbow		0.52	2	290	280	j				DEQ
OCHOCO RESERVOIR AT DEEPEST POINT	05/01/94	Trout Rainbow		0.55	2	310	395	j				DEQ
OCHOCO RESERVOIR AT DEEPEST POINT	05/15/94	Trout Rainbow		0.6	2	310	335	j				DEQ
OCHOCO RESERVOIR AT DEEPEST POINT	05/01/94	Trout Rainbow		0.62	2	280	285	j				DEQ
OCHOCO RESERVOIR AT DEEPEST POINT	05/01/94	Trout Rainbow		0.63	2	285	260	j				DEQ
OCHOCO RESERVOIR AT DEEPEST POINT	05/01/94	Trout Rainbow		0.67	2	280	315	j				DEQ
OCHOCO RESERVOIR AT DEEPEST POINT	01/01/90	Trout Rainbow		0.79	2					f		OSU
OWYHEE RESERVOIR (UPPER MOST REACH)	06/06/89	Catfish Channel		0.64		279.4				f		Hibbs
OWYHEE RESERVOIR (UPPER MOST REACH)	06/06/89	Catfish Channel		0.7		274.32				f		Hibbs
OWYHEE RESERVOIR (UPPER MOST REACH)	06/06/89	Catfish Channel		1		314.96				f		Hibbs
OWYHEE RESERVOIR AT 3-FINGERS	06/06/89	Bass Largemouth		0.23		284.48				f		Hibbs
OWYHEE RESERVOIR AT ACTION GULCH	06/06/89	Bass Largemouth		0.48		320.04				f		Hibbs
OWYHEE RESERVOIR AT ACTION GULCH	06/06/89	Bass Smallmouth		0.66		284.48				f		Hibbs
OWYHEE RESERVOIR AT ACTION GULCH	06/06/89	Crappie Black		0.36		190.5				f		Hibbs
OWYHEE RESERVOIR AT ACTION GULCH	06/06/89	Crappie White		0.32		304.8				f		Hibbs
OWYHEE RESERVOIR AT ACTION GULCH	06/06/89	Crappie White		0.34		287.02				f		Hibbs
OWYHEE RESERVOIR AT ACTION GULCH	06/06/89	Crappie White		0.34		279.4				f		Hibbs
OWYHEE RESERVOIR AT ACTION GULCH	06/06/89	Crappie White		0.39		279.4				f		Hibbs
OWYHEE RESERVOIR AT AIRPORT	06/06/89	Catfish Channel		0.75		330.2				f		Hibbs
OWYHEE RESERVOIR AT AIRPORT	06/06/89	Crappie Black		0.43		228.6				f		Hibbs
OWYHEE RESERVOIR AT AIRPORT	06/06/89	Crappie Black		0.55		210.82				f		Hibbs
OWYHEE RESERVOIR AT CATFISH HOLE	06/06/89	Bass Largemouth		0.47		269.24				f		Hibbs
OWYHEE RESERVOIR AT CATFISH HOLE	06/06/89	Bass Largemouth		0.77		266.7				f		Hibbs
OWYHEE RESERVOIR AT CATFISH HOLE	06/06/89	Bass Largemouth		1.39		287.02				f		Hibbs
OWYHEE RESERVOIR AT DOE ISLAND	06/06/89	Crappie Black		0.17		215.9				f		Hibbs
OWYHEE RESERVOIR AT DRY CR ARM	06/06/89	Bass Largemouth		0.78		304.8				f		Hibbs
OWYHEE RESERVOIR AT DRY CR ARM	06/06/89	Bass Largemouth		1.03		254				f		Hibbs
OWYHEE RESERVOIR AT DRY CR ARM & D/S STATE PARK	09/28/94	Bass Smallmouth		0.78		365			2	f		DEQ
OWYHEE RESERVOIR AT DRY CR ARM & D/S STATE PARK	09/28/94	Catfish Channel		0.68		285			2.1	f		DEQ
OWYHEE RESERVOIR AT DRY CR ARM & D/S STATE PARK	09/28/94	Catfish Channel		0.68		300			2.1	f		DEQ
OWYHEE RESERVOIR AT DRY CR ARM & D/S STATE PARK	09/28/94	Catfish Channel		0.75		310			2.9	f		DEQ
OWYHEE RESERVOIR AT DRY CR ARM & D/S STATE PARK	09/28/94	Catfish Channel		0.78		325			2.1	f		DEQ
OWYHEE RESERVOIR AT DRY CR ARM & D/S STATE PARK	09/28/94	Catfish Channel		0.82		385			2.4	f		DEQ
OWYHEE RESERVOIR AT DRY CR ARM & D/S STATE PARK	09/28/94	Catfish Channel		0.89		270			2.5	f		DEQ
OWYHEE RESERVOIR AT DRY CR ARM & D/S STATE PARK	09/28/94	Catfish Channel		0.94		290			2.3	f		DEQ
OWYHEE RESERVOIR AT DRY CR ARM & D/S STATE PARK	09/28/94	Catfish Channel		1.08		350			2	f		DEQ
OWYHEE RESERVOIR AT DRY CR ARM & D/S STATE PARK	09/28/94	Catfish Channel		1.39		295			2.1	f		DEQ

Location Description	Date	Species	Trkt	Mercury	Age	Length	Weight	Sex	Lipid	Type	Number	Lab
OWYHEE RESERVOIR AT DRY CR ARM & D/S STATE PARK	09/28/94	Perch Yellow		0.42		200			2.4	f		DEQ
OWYHEE RESERVOIR AT DRY CR ARM & D/S STATE PARK	09/28/94	Perch Yellow		0.45		200			2	f		DEQ
OWYHEE RESERVOIR AT DRY CR ARM & D/S STATE PARK	09/28/94	Perch Yellow		1.04		235			2.1	f		DEQ
OWYHEE RESERVOIR AT ELBOW	06/06/89	Bass Largemouth		0.43		292.1				f		Hibbs
OWYHEE RESERVOIR AT ELBOW	06/06/89	Bass Largemouth		0.97		284.48				f		Hibbs
OWYHEE RESERVOIR AT ELBOW	06/06/89	Catfish Channel		0.62		330.2				f		Hibbs
OWYHEE RESERVOIR AT ELBOW	06/06/89	Crappie Black		0.65		228.6				f		Hibbs
OWYHEE RESERVOIR AT ELBOW	06/06/89	Crappie Black		0.72		213.36				f		Hibbs
OWYHEE RESERVOIR AT ELBOW	06/06/89	Crappie Black		0.73		215.9				f		Hibbs
OWYHEE RESERVOIR AT ELBOW	06/06/89	Crappie Black		0.77		220.98				f		Hibbs
OWYHEE RESERVOIR AT ELBOW	06/06/89	Crappie Black		0.81		228.6				f		Hibbs
OWYHEE RESERVOIR AT ELBOW	06/06/89	Crappie White		0.2		330.2				f		Hibbs
OWYHEE RESERVOIR AT ELBOW	06/06/89	Crappie White		0.27		355.6				f		Hibbs
OWYHEE RESERVOIR AT ELBOW	06/06/89	Crappie White		0.36		279.4				f		Hibbs
OWYHEE RESERVOIR AT ELBOW	06/06/89	Crappie White		0.37		330.2				f		Hibbs
OWYHEE RESERVOIR AT ELBOW	06/06/89	Crappie White		1.18		304.8				f		Hibbs
OWYHEE RESERVOIR AT GREY CABIN	06/06/89	Bass Largemouth		0.65		276.86				f		Hibbs
OWYHEE RESERVOIR AT GREY CABIN	06/06/89	Bass Largemouth		0.69		284.48				f		Hibbs
OWYHEE RESERVOIR AT GREY CABIN	06/06/89	Bass Largemouth		0.77		299.72				f		Hibbs
OWYHEE RESERVOIR AT GREY CABIN	06/06/89	Bass Largemouth		0.92		292.1				f		Hibbs
OWYHEE RESERVOIR AT GREY CABIN	06/06/89	Catfish Channel		0.24		304.8				f		Hibbs
OWYHEE RESERVOIR AT GREY CABIN	06/06/89	Catfish Channel		0.34		304.8				f		Hibbs
OWYHEE RESERVOIR AT GREY CABIN	06/06/89	Catfish Channel		0.5		292.1				f		Hibbs
OWYHEE RESERVOIR AT GREY CABIN	06/06/89	Catfish Channel		0.56		330.2				f		Hibbs
OWYHEE RESERVOIR AT GREY CABIN	06/06/89	Catfish Channel		0.98		368.3				f		Hibbs
OWYHEE RESERVOIR AT GREY CABIN	06/06/89	Crappie Black		0.36		228.6				f		Hibbs
OWYHEE RESERVOIR AT GREY CABIN	06/06/89	Crappie Black		0.74		228.6				f		Hibbs
OWYHEE RESERVOIR AT GREY CABIN	06/06/89	Crappie White		0.38		279.4				f		Hibbs
OWYHEE RESERVOIR AT HOT SPRINGS	06/06/89	Bass Largemouth		0.72		297.18				f		Hibbs
OWYHEE RESERVOIR AT HOT SPRINGS	06/06/89	Catfish Channel		0.43		320.04				f		Hibbs
OWYHEE RESERVOIR AT LESLIE GULCH	06/06/89	Bass Largemouth		0.58		297.18				f		Hibbs
OWYHEE RESERVOIR AT RM 40	01/01/92	Bass Smallmouth		0.48	3					f		OSU
OWYHEE RESERVOIR AT RM 40	01/01/92	Bass Smallmouth		0.48	3					f		OSU
OWYHEE RESERVOIR AT RM 40	01/01/92	Bass Smallmouth		0.6	3					f		OSU
OWYHEE RESERVOIR AT RM 40	01/01/92	Bass Smallmouth		0.61	3					f		OSU
OWYHEE RESERVOIR AT RM 40	09/19/90	Bass Smallmouth		0.63	5					f		OSU
OWYHEE RESERVOIR AT RM 40	01/01/92	Bass Smallmouth		0.63	3					f		OSU
OWYHEE RESERVOIR AT RM 40	09/19/90	Bass Smallmouth		0.65	3					f		OSU

Location Description	Date	Species	Text	Mercury	Age	Length	Weight	Sex	Lipid	Type	Number	Lab
OWYHEE RESERVOIR AT RM 40	01/01/92	Bass Smallmouth		0.73	4					f		OSU
OWYHEE RESERVOIR AT RM 40	09/19/90	Bass Smallmouth		0.75	2					f		OSU
OWYHEE RESERVOIR AT RM 40	09/19/90	Bass Smallmouth		0.79	3					f		OSU
OWYHEE RESERVOIR AT RM 40	01/01/92	Bass Smallmouth		0.9	4					f		OSU
OWYHEE RESERVOIR AT RM 40	01/01/92	Bass Smallmouth		0.97	4					f		OSU
OWYHEE RESERVOIR AT RM 40	09/19/90	Bass Smallmouth		1.16	4					f		OSU
OWYHEE RESERVOIR AT RM 40	01/01/92	Bass Smallmouth		1.18	5					f		OSU
OWYHEE RESERVOIR AT RM 40	01/01/92	Bass Smallmouth		2.54	5					f		OSU
OWYHEE RESERVOIR AT RM 42	08/27/87	Bass Largemouth		1.06		279.4	363			f		DEQ
OWYHEE RESERVOIR AT RM 42	08/27/87	Bass Smallmouth		1.77		328.295	465			f	4	DEQ
OWYHEE RESERVOIR AT RM 42	08/31/87	Catfish Channel		1.19		326.39				f	4	DEQ
OWYHEE RESERVOIR AT RM 42	08/27/87	Catfish Channel		1.47		466.09				f	2	DEQ
OWYHEE RESERVOIR AT RM 42	08/27/87	Crappie Black		0.62		203.2	181			f	4	DEQ
OWYHEE RIVER AT BOGUS CREEK	09/01/89	Bass Smallmouth		0.21		182.88	0			f		Hibbs
OWYHEE RIVER AT BOGUS CREEK	09/01/89	Bass Smallmouth		0.24		198.12	0			f		Hibbs
OWYHEE RIVER AT BOGUS CREEK	09/01/89	Bass Smallmouth		0.3		213.36				f		Hibbs
OWYHEE RIVER AT BOGUS CREEK	09/01/89	Bass Smallmouth		0.52		215.9				f		Hibbs
OWYHEE RIVER AT BOGUS CREEK	09/01/89	Bass Smallmouth		0.74		241.3				f		Hibbs
OWYHEE RIVER AT BOGUS CREEK	09/01/89	Catfish Channel		0.28		215.9				f		Hibbs
OWYHEE RIVER AT BOGUS CREEK	09/01/89	Catfish Channel		0.3		279.4				f		Hibbs
OWYHEE RIVER AT BOGUS CREEK	09/01/89	Catfish Channel		0.41		266.7				f		Hibbs
OWYHEE RIVER AT BOGUS CREEK	09/01/89	Catfish Channel		0.49		241.3				f		Hibbs
OWYHEE RIVER AT BOGUS CREEK	09/01/89	Catfish Channel		0.68		228.6				f		Hibbs
OWYHEE RIVER AT MOUTH	11/02/93	Carp		0.241		600	5550		25.49	wb	2	DEQ
OWYHEE RIVER AT MOUTH	11/02/93	Carp		0.283		628	5067	m	10.11	wb	3	DEQ
OWYHEE RIVER AT MOUTH	11/02/93	Carp		0.382		683.333	6867		6.92	wb	3	DEQ
OWYHEE RIVER AT OWYHEE JCT.	09/01/89	Catfish Channel		0.16		254				f		Hibbs
OWYHEE RIVER AT OWYHEE JCT.	09/01/89	Catfish Channel		0.18		241.3				f		Hibbs
OWYHEE RIVER AT OWYHEE JCT.	09/01/89	Catfish Channel		0.18		266.7				f		Hibbs
OWYHEE RIVER AT OWYHEE JCT.	09/01/89	Catfish Channel		0.21		279.4				f		Hibbs
OWYHEE RIVER AT OWYHEE JCT.	09/01/89	Catfish Channel		0.33		241.3				f		Hibbs
OWYHEE RIVER AT ROME	09/01/89	Bass Smallmouth		0.23		215.9	1			f		Hibbs
OWYHEE RIVER AT ROME	09/01/89	Bass Smallmouth		0.3		228.6				f		Hibbs
OWYHEE RIVER AT ROME	09/01/89	Bass Smallmouth		0.3		228.6	1			f		Hibbs
OWYHEE RIVER AT ROME	09/01/89	Bass Smallmouth		0.6		218.44				f		Hibbs
OWYHEE RIVER AT ROME	09/01/89	Bass Smallmouth		0.93		220.98				f		Hibbs
OWYHEE RIVER AT ROME	09/01/89	Catfish Channel		0.29		254				f		Hibbs
OWYHEE RIVER AT ROME	09/01/89	Catfish Channel		0.36		254				f		Hibbs

Location Description	Date	Species	Text	Mercury	Age	Length	Weight	Sex	Lipid	Type	Number	Lab
OWYHEE RIVER AT ROME	09/01/89	Catfish Channel		0.38		304.8				f		Hibbs
OWYHEE RIVER AT ROME	09/01/89	Catfish Channel		0.49		228.6				f		Hibbs
OWYHEE RIVER AT ROME	09/01/89	Catfish Channel		0.57		279.4				f		Hibbs
OWYHEE RIVER BELOW RESERVOIR RM 23	09/01/89	Trout Rainbow		0.2		325.12				f		Hibbs
OWYHEE RIVER BELOW RESERVOIR RM 23	09/01/89	Trout Rainbow		0.25		337.82				f		Hibbs
OWYHEE RIVER BELOW RESERVOIR RM 23	09/01/89	Trout Rainbow		0.27		330.2				f		Hibbs
OWYHEE RIVER BELOW RESERVOIR RM 23	09/01/89	Trout Rainbow		0.37		381				f		Hibbs
OWYHEE RIVER BELOW RESERVOIR RM 23	09/01/89	Trout Rainbow		0.42		365.76				f		Hibbs
PAULINA LAKE AT DEEPEST POINT	05/10/94	Trout Brook	<	0.025		160	53			f		AGI
PAULINA LAKE AT DEEPEST POINT	05/10/94	Trout Brook	<	0.025		150	57			f		AGI
PAULINA LAKE AT DEEPEST POINT	05/10/94	Trout Brook	<	0.025		165	71			f		AGI
PAULINA LAKE AT DEEPEST POINT	05/10/94	Trout Brown	<	0.025		355	470			f		AGI
PAULINA LAKE AT DEEPEST POINT	06/08/94	Trout Brown		0.06	4	390	585	j	1.5	f		DEQ
PAULINA LAKE AT DEEPEST POINT	06/08/94	Trout Brown		0.06	4	400	630	m	1.4	f		DEQ
PAULINA LAKE AT DEEPEST POINT	06/08/94	Trout Brown		0.06	4	430	910	m	3.1	f		DEQ
PAULINA LAKE AT DEEPEST POINT	05/10/94	Trout Brown		0.11		445	1210			f		AGI
PAULINA LAKE AT DEEPEST POINT	05/10/94	Trout Rainbow	<	0.025		310	396			f		AGI
PAULINA LAKE AT DEEPEST POINT	05/10/94	Trout Rainbow	<	0.025		255	206			f		AGI
PAULINA LAKE AT DEEPEST POINT	05/10/94	Trout Rainbow	<	0.025		285	315			f		AGI
PAULINA LAKE AT DEEPEST POINT	06/08/94	Trout Rainbow		0.03	3	280	270	m	1.1	f		DEQ
PAULINA LAKE AT DEEPEST POINT	06/08/94	Trout Rainbow		0.03	3	340	460	m	2.2	f		DEQ
PAULINA LAKE AT DEEPEST POINT	06/08/94	Trout Rainbow		0.03	3	275	240	m	1.2	f		DEQ
PAULINA LAKE AT DEEPEST POINT	05/10/94	Trout Rainbow		0.08		420	974			f		AGI
PHILLIPS LAKE AT DEEPEST POINT	09/27/94	Bass Smallmouth		0.27	3	250	185			f		DEQ
PHILLIPS LAKE AT DEEPEST POINT	09/27/94	Bass Smallmouth		0.39	4	250	185			f		DEQ
PHILLIPS LAKE AT DEEPEST POINT	09/27/94	Bass Smallmouth		0.39	3	220	120			f		DEQ
PHILLIPS LAKE AT DEEPEST POINT	09/27/94	Bass Smallmouth		0.4	3	235	155			f		DEQ
PHILLIPS LAKE AT DEEPEST POINT	09/27/94	Bass Smallmouth		0.41	3	265	235			f		DEQ
PHILLIPS LAKE AT DEEPEST POINT	09/27/94	Crappie Black		0.35	3	205	125			f		DEQ
PHILLIPS LAKE AT DEEPEST POINT	09/27/94	Crappie Black		0.39	5	250	205	f		f		DEQ
PHILLIPS LAKE AT DEEPEST POINT	09/27/94	Trout Rainbow		0.14	1	230	95			f		DEQ
PHILLIPS LAKE AT DEEPEST POINT	09/27/94	Trout Rainbow		0.15	1	225	95			f		DEQ
PHILLIPS LAKE AT DEEPEST POINT	09/27/94	Trout Rainbow		0.16	1	220	95			f		DEQ
PRINEVILLE RESERVOIR AT POWDER HOUSE COVE	06/01/93	Bass Smallmouth		0.151		151	72		0.2	f	7	DEQ
PRINEVILLE RESERVOIR AT POWDER HOUSE COVE	06/01/93	Bullhead Yellow		0.066		212.14	108		0.4	wb	7	DEQ
PRINEVILLE RESERVOIR AT POWOER HOUSE COVE	06/01/93	Sucker Coarsescale		0.058		341.25	486		5.6	wb	4	DEQ
ROW RIVER	05/15/94	Bass Largemouth		0.29	3	280	308		1.7	f		DEQ
ROW RIVER	05/15/94	Bass Largemouth		0.4	3	306	408	m	1.4	f		DEQ

Location Description	Date	Species	Text	Mercury	Age	Length	Weight	Sex	Lipid	Type	Number	Lab
ROW RIVER	05/15/94	Bass Largemouth		0.41	4	329	465		1.3	f		DEQ
ROW RIVER	05/15/94	Bass Largemouth		0.44	3	296	314	m	1.2	f		DEQ
ROW RIVER	05/15/94	Bass Largemouth		0.58	3	339	630		1.3	f		DEQ
ROW RIVER	05/15/94	Trout Cutthroat		0.09	1	205	74	j	1.3	f		DEQ
ROW RIVER	05/15/94	Trout Cutthroat		0.09	1	207	82	j	1.5	f		DEQ
ROW RIVER	05/15/94	Trout Cutthroat		0.1	1	188	52	j	1.4	f		DEQ
ROW RIVER	05/15/94	Trout Cutthroat		0.1	1	179	50	j	1.1	f		DEQ
ROW RIVER	05/15/94	Trout Cutthroat		0.13	1	203	78	j	0.9	f		DEQ

LEGEND:

Mercury: mg Hg/kg

Age: Years

Length: mm

Weight: grams

Sex: Male (m) — Female (f) — Juvenile (j)

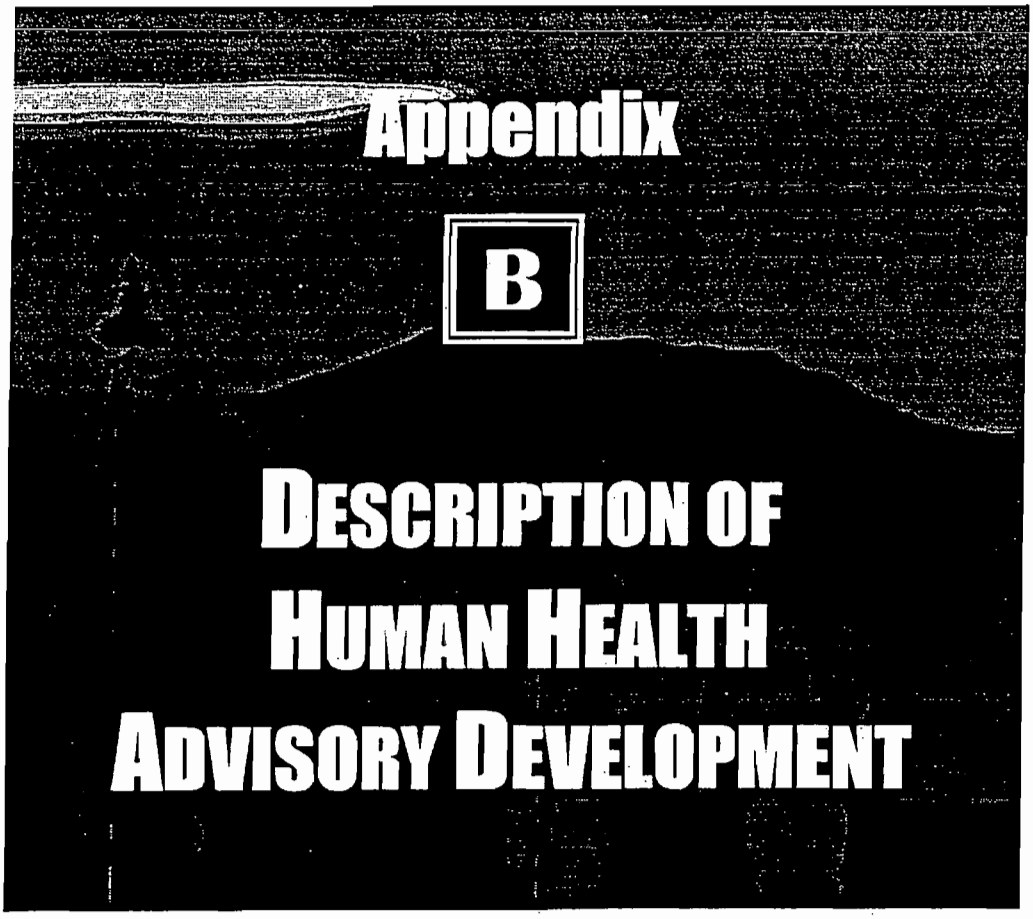
Lipid: % Wet Weight

Type: Filet (f) — Whole Body (wb)

Text: <, > Results

Number: Number in Composite (if sample is more than 1)

Lab: Analytical Lab



Appendix

B

Description of Human Health Advisory Development

Source:

Oregon Health Division — February 13, 1995

February 13, 1995

Health Division Fish Mercury Policy and Assessment Assumptions

Due to the growing awareness of state agencies and Oregon citizens about the presence of natural mercury in numerous waterways in the state; and the impact that such mercury can have, the Health Division has been asked for a concise statement of the assumptions and criteria used for determining the safety of sport-caught fish taken from mercury-affected waterways.

The first mercury advisory issued in Oregon was initiated by Lane County Health Department in 1978, and was brought about by mercury tests showing levels of mercury in some fish from Cottage Grove Reservoir well above the US FDA market limit of 1 ppm. The advisory recommends reduced consumption of fish by everyone, with particular restrictions on pregnant women and small children.

Since that time additional fish-mercury advisories have been issued by the Health Division for Jordan Creek, Antelope Reservoir and Owyhee Reservoir (Malheur County), and for East Lake (Deschutes County).

The Health Division is currently maintaining a fish mercury database which includes all historical data available from any source, and which is updated to include any new mercury data that comes to the attention of the Health Division. The basic criteria currently used by the agency in determining where advisories are warranted are as follows:

1. The initial indication that fish from a particular body of water may pose a hazard to consumers is when the overall average mercury level reaches or exceeds 0.6 ppm. This level is the US EPA "screening value" which is meant to serve as a red flag to government agencies that fish from that particular body of water may be potentially hazardous. It is necessary also that there be sufficient numbers of fish tested involving a variety of species and sizes for the average mercury value to be meaningful. Rarely do we have a statistically adequate sampling, but the sampling must include several species and a significant number of fish.

2. When the average mercury value reaches or exceeds 0.6 ppm a careful review of all of the data is done. The average mercury level of each species is reviewed; correlations of mercury levels with size (or age) of fish are reviewed; any available information about fishing habits and characteristics of the consuming population are reviewed; and any other relevant factors are taken into account. If mercury levels are so high that

fish consumption should be avoided entirely, or if there are specially susceptible populations that would be adversely affected by eating the fish; advisories will be issued that recommend against consumption.

3. Frequently mercury levels are high enough to pose some hazard to high consumption users or to specially sensitive populations, but not so high as to warrant advising no consumption. In these cases the Health Division will issue advisories stating how much fish can be eaten by various groups of consumers. If there is sufficient data showing that a given species or size (age) of fish does not have excessive mercury levels, these fish might be excluded from the advisory.

4. Where the amount of test data is sufficient to warrant it, the Health Division will also include advisory information about species or fish sizes (ages) that pose unique hazards. For example, the advisory may state that a certain species of fish larger than a specified size should not be used for food.

5. In cases in which the average mercury level for fish from a given body of water does not exceed the 0.6 ppm "screening value", but there is significant test data for one or more species indicating that there are excessive levels of mercury in that species or that size category; an assessment and advisory may be done for the most affected fish.

6. In cases in which the average mercury level is less than the screen value, but it is known that there is a population of consumers that consumes abnormally large amounts of the fish; or if there is a population of consumers that has susceptibilities that are abnormally great; the Health Division may perform an assessment and issue advisories for those unique populations.

TF0213KK.M41

Oregon Human Resources **News**

Health Division

For Immediate Release March 3, 1995

Contacts: Duncan Gilroy, Ken Kauffman, OR Health Division, (503) 731-4015
Al Smith, OR Dept Fish and Wildlife, (503) 229-5474
Avis Newell, DEQ, Water Quality Section, (503) 229-6982
Roger Everett, Deschutes County Health, (503) 388-6575

FISH MERCURY ADVISORY REVISED FOR EAST LAKE, NEWBERRY CRATER, DESCHUTES COUNTY

(PORTLAND)--State Health Division officials today released a revised fish consumption advisory for all species of fish taken from East Lake, a popular fishing resort in Newberry Crater in central Oregon. An advisory recommending limiting consumption of fish from that lake was issued in June 1994. Additional testing of fish since that time has shown that mercury levels are higher than the levels seen during the 1994 assessment, according to Ken Kauffman of the Health Division's Environmental Toxicology section.

The Health Division is now recommending that consumption of all species of fish be reduced further, and that brown trout smaller than the previous 22 inch limit, pose a particular problem. The new recommendations are as follows:

1. Pregnant women, nursing mothers, infants, and children less than 6 years old should not eat more than 8 ounces (one meal) of fish from East Lake in any six month period (such persons should consider avoiding consumption of any fish from this lake);

2. Women of child-bearing age should not eat more than one 8-ounce meal every six weeks;

3. Other healthy adults and children over six years of age should consume no more than 8 ounces of fish every 10 days; and

4. Brown trout 16 inches long or larger should not be used for food.

These recommended limits are more restrictive than the recommendations in the June, 1994 advisory that is currently in effect.

-MORE-

800 N.E. Oregon #21, Portland, OR 97232

The source of the mercury in fish from East Lake appears to be the natural soil and rocks in the crater. Fish taken from Paulina Lake continue to show levels of mercury that are within acceptable health limits.

Because sport fishing at East Lake is a popular activity, Oregon agencies encourage catch-and-release techniques be used at this lake, particularly for larger, older specimens of any species.

Since fish mercury, known as methylmercury, is dispersed throughout edible fish tissue, the only way a person can avoid or reduce exposure is to limit the amount of fish eaten. Preparation techniques such as cooking, brining, smoking, curing, freezing, or storage processes do not significantly reduce contamination or hazards from methylmercury.

Health Division officials stressed that persons most sensitive to methylmercury effects are developing fetuses, pregnant women, breastfed infants, and children younger than six years old. Methylmercury can adversely effect the brain and central nervous systems of fetuses and small children. Ingested methylmercury is gradually excreted over time, but injury to vital organs can occur while body loads are elevated.

This fish advisory is based on data obtained from recent fish tissue studies conducted by the Department of Environmental Quality in cooperation with Oregon Department of Fish and Wildlife and the Health Division. The calculated average level of fish mercury in tissue from fish in East Lake, when the most recent tests are included, is 0.74 ppm (up from 0.64 ppm in June, 1994). This level exceeds the US EPA screening level for fish mercury.

Large brown trout (22 inches and larger) taken from East Lake have been found to have very high mercury levels, approaching 3 ppm; and recent tests showed brown trout of 16 inches to have levels approaching 2 ppm.

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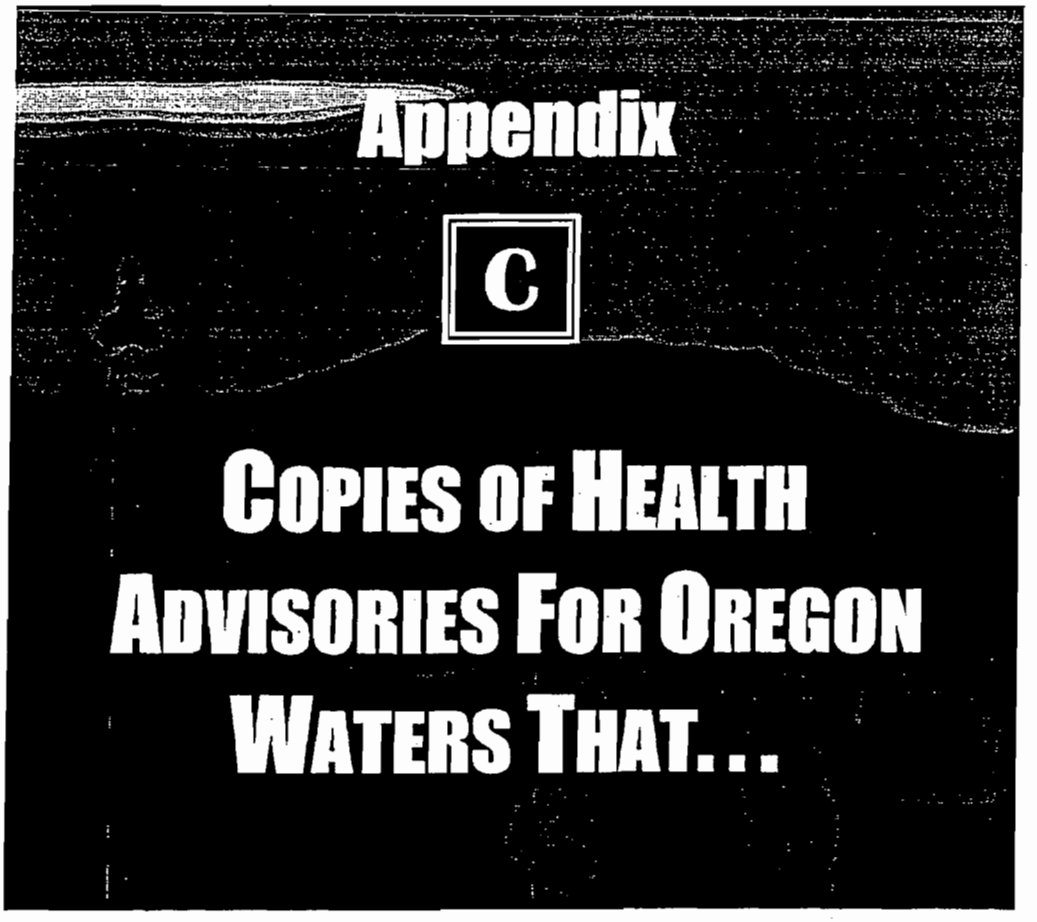

Appendix

C

Copies of Health Advisories For Oregon Waters That...

Recommend Fish Consumption Levels Based on Mercury Contamination

CONTACT:

Catherine Neumann, Ph.D. Oregon Health Division 503-731-4015
Ken Kauffman, R.S., Oregon Health Division, 503-731-4015
Ray Huff, Malheur County Health Department 503-473-3185
Barbara Stifel, Oregon Department of Environmental Quality, 503-229-6982.

For Immediate Release February 10, 1994

ELEVATED LEVELS OF MERCURY FOUND IN FISH TISSUE FROM OWYHEE RESERVOIR

(PORTLAND) Malheur County and Oregon Health Division (OHD) officials, in coordination with other affected state agencies, advise the public to limit the amount of fish eaten from the Owyhee Reservoir. The Owyhee River (upstream Jordon Creek and downstream from the reservoir to the Snake River) is not included in today's advisory. Fishing from Jordon Creek and Antelope Reservoir remains prohibited due to high levels of mercury.

Today's advisory is based on several sampling surveys conducted by the Oregon Department of Fish and Wildlife (ODFW), Department of Environmental Quality (DEQ) and Oregon State University which detected high levels of mercury in several fish species throughout the Owyhee reservoir. Catherine Neumann, the toxicologist with the Health Division said, "This advisory is necessary due to recent studies suggesting that the fetus, pregnant women and young children would be at an increased risk to adverse nervous system effects from repeated exposure to methylmercury in fish tissue at levels above 0.6 ppm."

Neumann said that the levels of mercury in fish from Owyhee Reservoir ranged between 0.65-1.77 ppm. Since mercury collects in edible portions of fish tissue, the only way to limit exposure is to reduce the amount of fish eaten from contaminated waterways. Therefore, OHD warns that pregnant women, nursing women and children up to 6 years of age should not consume any fish from this body of water. Children older than 6 years and healthy adults should limit their consumption of fish from Owyhee Reservoir to no more than one-half pound (eight ounces) of fish six times a year (approximately one meal every other month). The U.S. Environmental Protection Agency is currently reviewing this health standard.

The source of the mercury appears to be from natural geological mercury in the rocks and soils in this area, and possibly, past mining activities. Additional fish sampling surveys will be conducted by DEQ and Oregon Department of Fish and Wildlife (ODFW) to further characterize the extent of mercury contamination.

Because sport fishing is a popular activity at Owyhee Reservoir, OHD and ODFW suggest that fishermen practice catch-and-release fishing. A catch-and-release approach allows fishermen

to still enjoy fishing as a high-quality recreational experience, according to ODFW officials.

Some tips on releasing fish include:

- o retrieve the catch quickly and release it immediately;
- o keep the fish in water as much as possible;
- o remove the hook or lure carefully;
- o leave deeply swallowed bait hooks in the fish by cutting off the line;
- o avoid squeezing the fish and if the fish does not swim away, help revive the fish.

The current fish advisory may need to be updated pending further sampling.

####

(503) 731-4015
FAX (503) 731-4077
Nonvoice (503) 731-4031

Oregon

DEPARTMENT OF
HUMAN
RESOURCES

HEALTH DIVISION

May 27, 1993

Richard Coots
Environmental Health
Lane County Health & Human Services
125 E 8th Avenue
Eugene, Oregon 97401

RE: Cottage Grove Reservoir Fish-Mercury Advisory Review and Update

Dear Rich:

This is to confirm the discussion you and I had on April 20, 1993 when we met with Herschel Henderly of the US Corps of Engineers at his office on the reservoir. Also present at the meeting were other corps employees and a local sportsman representative Lindsey Haskell. We had invited Oregon Fish and Wildlife officials to join us but they declined because the discussion was primarily one of human health protection.

The purpose of our meeting was to review the history and status of the mercury advisory that has existed on the reservoir since April 1979. That initial advisory was imposed by John Stoner of your office, and it was modified slightly in 1987 by Dave Phelps of the Health Division's office of Environmental Services and Consultation. There have been no revisions or modifications to the Health Division advisory since that date.

Apparently, there have been changes in the fishing regulations on the reservoir and changes in the appearance and style of the advisory notices that are posted. The only notice of the advisory that is currently posted at the reservoir is stated on the US Corps of Engineer visitor signs. The recommended consumption limitations are not stated very clearly, nor is the location and design of the notices such that persons are likely to see or read them.

We briefly reviewed the testing of fish from the reservoir. There have been only four fish-testing studies to our knowledge; one occurring in 1974 to 1979, another in 1979, another in 1987 and the

Barbara Roberts
Governor

800 NE Oregon Street # 21
Portland, OR 97232
(503) 731-4030 Emergency
(503) 252-7978 TDD
Emergency

24-26 (Rev 1-92)

latest in 1990. A variety of species and age/size groups were tested. The range of methylmercury findings in the fish for all studies is 0.22 to 1.79 ppm. One percent, actually one fish, exceeded 1.5 (1.79 ppm.)

Nine percent had between 1.0 and 1.5 ppm. Sixty three percent contained between 0.5 and 1.0 ppm. All others had less than 0.5 ppm of methylmercury. In other words ten percent of the fish tested exceeded the current US FDA commercial fish standard for methylmercury (1.0 ppm).

The studies do not show any clear trends, so we cannot say whether mercury levels are increasing or decreasing in the fish populations in the reservoir. The limited data available suggests that the levels have been quite stable since 1974. It is probably safe to assume that geological mercury continues to enter the reservoir, but we cannot predict future impacts on fish from information known. Continued monitoring and study of tissue levels are needed.

Consequently, we do not see any reason to significantly modify the content of our public consumption advisory for fish taken from Cottage Grove Reservoir. We would suggest minor changes in the language to read as follows:

WARNING TO FISHERS

Fish taken from this reservoir frequently contain elevated levels of mercury that can be harmful to health. It is believed that the source of the mercury is normal geological mercury in the rocks and soils of this area. The Oregon Health Division and Lane County Health Department advise you to limit your eating of these fish as follows:

1. Pregnant women, nursing women and children up to six years of age should not consume any fish from this reservoir;

2. Children older than six years and healthy adults should limit their consumption of fish from this reservoir to no more than one half pound (8 ounces) of fish from this reservoir per week.

If you have questions about this advisory please call Lane County Health Department at _____.

We do not object to the inclusion of this advisory in the information signs provided by the Corps, but we do not believe these are sufficiently noticeable to attract the attention of many recreational users at the reservoir. We recommend that signs of bright color (black on yellow for example) that are prominently headed as warnings are needed at all major fishing spots around the reservoir. As there is a significant Hispanic population in the area, we recommend that the notices be bilingual, English and Hispanic. Because of theft and vandalism potential, regular maintenance will be important.

I am sending a copy of this recommendation to Herschel Henderly and to the Oregon Fish and Wildlife Department. Please feel free to call me if you want to discuss anything.

Sincerely,

Kenneth W. Kauffman, R.S.
Environmental Health Specialist
Environmental Services & Consultation Section
Center for Environmental Health

KWK:ab

CC: Cathy Neumann, Toxicologist
Herschel Henderly, US Army Corps of Engineers, Cottage Grove Reservoir offices
Al Smith, Oregon Fish and Wildlife Department
Greg Robart, Oregon Fish and Wildlife Department
Andy Schaedel, Mercury Study Group, Surface Water Section, Department of Environmental Quality

TF0525KK.M41

NEIL GOLDSCHMIDT
GOVERNOR

Department of Human Resources
HEALTH DIVISION
1400 SW 5th AVENUE, PORTLAND, OREGON 97201 VOICE: 229-5821
TDD-NONVOICE: (503) 229-5497

December 12, 1989

Ray Temple, Manager
Warm Water Miscellaneous Species Program
Fish Division
Oregon Fish & Wildlife Department
506 SW Mill Street
Portland, Oregon 97201

Dear Mr. Temple:

This is to follow up on our interagency meeting of December 5, 1989 and to revise our recommendations regarding mercury levels found in fish from Antelope Reservoir, Jordan Creek, and Owyhee Reservoir in Malheur County.

As you recall, on December 19, 1988, we recommended that sport fishing advisories be issued regarding unsafe mercury levels in fish tested from both Owyhee and Antelope Reservoirs. No advisories were issued because a special sampling project was undertaken to ascertain whether the levels measured to that date were accurate and truly representative of the wider fish populations.

We now have the results of that additional testing, and the results have altered our recommendations as follows:

Antelope Reservoir and Jordan Creek

Considering the results of tests performed by the private laboratory together with the findings of the Department of Environmental Quality laboratory, we conclude that there is an even greater hazard from fish in Antelope Reservoir and Jordan Creek than observed in 1987-1988. The latest results from the DEQ laboratory show that the levels of mercury in fish tested from the Antelope system range from 2.41 mg/kg to 3.57 mg/kg with a mean value of 2.9 mg/kg. This is almost 3 times the level allowable by U.S. FDA for commercial fish products, and these levels pose a significant risk of mercury toxicity to sportfish consumers. We recommend that a warning be published in the anglers guide and posted prominently by signs located at public access points to Antelope Reservoir and Jordan Creek extending to its confluence with Owyhee River. The notice should read as follows:

ATTENTION FISHERMEN

The State Health Division has determined that fish taken from these waters contain mercury in potentially hazardous quantities. To avoid serious health effects you should limit consumption as follows:

A. Pregnant Women, children 6 years old or younger and adults with kidney or liver damage should not eat any fish taken here;

B. Children between 6 and 16 years of age should not eat more than 1/6 pound (2 1/2 ounces) of fish from here per month;

C. Healthy adults should not eat more than 1/3 pound (5.3 ounces) of fish from here per month.

Oregon Health Division
Oregon Department of Fish and Wildlife
Oregon Department of Environmental Quality

We urge that these notices be issued and posted as soon as physically possible.

Owyhee Reservoir

The testing data developed during the current study of fish from the Owyhee River and Reservoir are not complete as outlined in the attached meeting summary, and at this point we are not certain whether they will warrant similar action. You will recall that we considered the 1987-1988 tests sufficient to require public notices, but our recommended consumption limits were less restrictive than those we are now recommending for the Antelope drainage.

We will await further information regarding the Owyhee system before commenting further.

Please call me if you want to discuss this recommendation or related matters.

Sincerely,

Kenneth W. Kauffman
Environmental Specialist
Non-Communicable Disease Section

cc: Bartels, Buckman, Herrig, Griggs; Temple, Daily, Hosford, - Fish and Wildlife

Eugene Foster, DEQ, Water Quality
Ray Huff, Malheur County Health Department